ENHANCED RECOVERY AFTER SURGERY

By

ROBIN WOTTON

A thesis submitted to the University of Birmingham for the degree of

MASTERS OF SCIENCE

School of Clinical and Experimental Medicine

College of Medical and Dental Sciences

University of Birmingham

ABSTRACT

The NHS is continually striving to improve patient care. Enhanced Recovery after Surgery (ERAS) initiatives have been proven to benefit patient care, reduce complication rates and shorten length of stay. The drive is efficacy and equity of care for all patients.

Originally developed in colorectal surgery and established in three other surgical specialities (gynaecological, urological and musculoskeletal surgery) the Department of Health, through the NHS Improvement framework, is driving the wider adoption of ERAS. The adoption of enhanced recovery principles in thoracic surgery is gathering pace. Birmingham Heartlands Hospital is at the forefront of driving the development of ERAS in thoracic surgery.

This project will establish the evidence base for key thoracic interventions on the ERAS pathway, show the results of the first national survey of thoracic ERAS practice and highlight the preliminary achievements on patient outcomes. The project will also show the results of visits to other thoracic surgical units and the gap analyses performed on their ERAS pathways. The project will also highlight the construction of the first manual for ERAS in thoracic surgery and patient information booklet. The resulting ERAS pathway can thus be used by others within the speciality of thoracic surgery to promote and enhance the care of their patients.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BMI- body mass index

CHO- carbohydrate drink

COPD- chronic obstructive pulmonary disease

CTS- cardiothoracic surgery

CXR- chest radiograph

DOS- day of surgery

DOSA- day of surgery admission

ECHO- echocardiogram

EP- electronic prescription

ER- enhanced recovery

ERAS- enhanced recovery after surgery

GFV- gastric fluid volume

H20- water

HDU- high dependency unit

ICD- intercostal drain (chest drain)

IQR- interquartile range (25th-75th percentiles)

ITU – intensive care unit

IV- intravenous

LAP. CHOLE- laparoscopic cholecystectomy

LOS- length of stay

MAMC- mid-arm muscle circumference

MCS- major colorectal surgery

NBM- nil by mouth

NSAIDs- non-steroidal anti-inflammatory drugs

OPC- outpatient clinic

PFT- pulmonary function test

PGR- post graduate researcher

POAC- pre-operative assessment clinic

PROM- patient reported outcome measure

PTX- pneumothorax

PVC- paravertebral catheter

RCT- randomised controlled trial

R+D- research and development

SSI- surgical site infections

TBP- total body protein

UHSM- University Hospital South Manchester

UTI- urinary tract infection

VAS- visual analogue scale

VATS- video assisted thoracoscopic surgery

WCC- white cell count

WR- ward round

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Concept of enhanced recovery

"…to enable patients to recover sooner…"

Enhanced recovery after surgery (ERAS) or 'fast-track' surgery was originally pioneered in the 1990's by Professor Henrik Kehlet in colorectal surgery [1]. By examining the roles of various components contributing to post-operative morbidity, he devised interventions to minimise the surgical stress on his patients. His multimodal approach was designed to reduce post-operative complications, facilitating earlier discharge from hospital and a reduction in healthcare expenditure.

The National Health Service (NHS) is continually striving to improve patient care and thus started using this approach, again most prominently in colorectal surgery, from the early 2000's. The clear benefits for both patients and healthcare providers resulted in the release of 'Delivering enhanced recovery- helping patients to get better sooner after surgery' in 2010 [2]. This document summarised the implementation of enhanced recovery (ER) within the NHS at that time and provided a road-map of how to set up an enhanced recovery pathway. For the first time it gave details of a generic ER pathway and the multi-step processes within it.

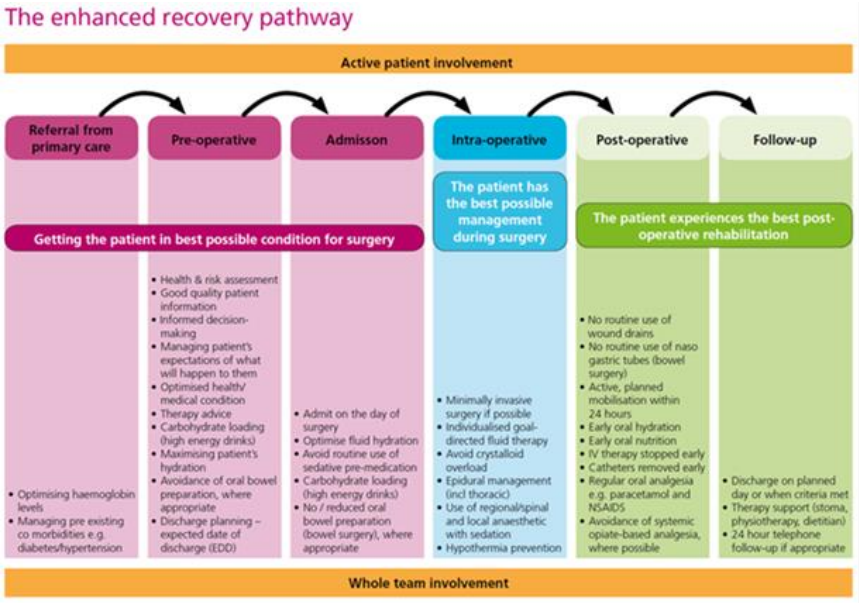


Figure 1: The original enhanced recovery pathway [adapted from ref 2]

The underlying principle of ERAS is to enable patients to recover sooner by minimising the stress responses on the body from surgery. But this doesn't just mean having the best operation. The figure illustrates the pathway and the number of individual peri-operative interventions along the entire patient journey. It starts at referral and continues until discharge. Each step is evidence based.

Successful implementation is achieved by:

- The patient being in the best possible condition for surgery

- The patient having the best possible management during and after their operation

- The patient experiencing the best possible post-operative rehabilitation

1.2 Colorectal surgery

The concept of ‘fast-track’ or enhanced recovery after surgery was pioneered in colorectal surgery. The results of enhanced recovery programmes in colorectal surgery have thus been evaluated in the greatest detail and have been the subject of several systematic reviews, meta-analyses and a Cochrane review [3-5]. For example standardised ER programmes encompassing pre-operative, in-hospital and post-operative care have been shown to result in a number of patient benefits. These include reduction in length of stay [5-11], reduction in morbidity [5,7,9] and promoting patient reported outcome measures [12], without increasing readmission rates [13-15]. Other advantages of ER programmes over standard or traditional perioperative care include earlier recovery and discharge after colonic resection [1,6,9,12].

Two systematic reviews evaluated the effects of an ER programme as compared to conventional care, in terms of mortality, morbidity, length of hospital stay and rate of readmissions [5,16]. These two studies evaluated 4 and 6 RCTs respectively [7,12,17-20] and showed no differences in mortality or rate of readmission, a reduction in morbidity and reduced length of hospital stay for those patients in an ER care pathway. These findings compare favourably with a meta-analysis of the same RCTs which confirmed these advantages of an ER care pathway [4].

In addition to clinical outcomes there has also been some attempt to quantify the benefits of ER on health economics. Although the literature is more limited, a few studies have speculated there may be reduced costs associated with ER programmes, as complication rates and readmission rates are lower [4,21,22].

This evidence has led to the construction and publication of ER programmes as consensus documents providing recommended guidelines for patients undergoing colorectal surgery [23-26]

1.3 Non-colorectal surgery

Compared to colorectal surgery, fewer studies have been conducted in other surgical specialities. However, since 2008, ER programmes have been reported to benefit patients undergoing urological, hepato-biliary, upper gastrointestinal and gynaecological surgery [27,30-34]. Studies have shown a reduction in length of stay for patients undergoing radical cystectomy [27], liver resection [28], oesophagectomy [29], laparoscopic gastric surgery [30] and hysterectomy [34]. Reduced pulmonary complications and mortality for patient undergoing oesophageal resection has also been shown [29], whilst for gastric resections, readmission rates have also fallen [30]. Some of the evidence in upper gastrointestinal surgery is conflicting. Whilst in principle ER has been shown to offer particular advantages, some authors have questioned the underlying evidence base due to the heterogeneity of reported studies [31,32], despite its apparent safety [32,33].

1.4 Thoracic surgery

Evidence for the benefits, or otherwise, of ER programmes in thoracic surgery is sparse. The adoption of ER principles and elements specifically designed for thoracic surgical practice has been slower. However, with the increase in lung cancer

prevalence, thoracic surgery is an expanding speciality. With the majority of thoracic surgery being elective, or non-emergency, surgery, the speciality lends itself to the implementation of enhanced recovery. Thus, the advantages of ER already demonstrated in non-thoracic surgery are starting to be implemented in thoracic surgery. More recently, thoracic surgery specific elements and pathways have been implemented [35-37]. These ER pathways have, in the main, been constructed from colorectal pathways, and incorporate the most suitable elements for thoracic surgery. Non-thoracic elements such as the routine use of bowel preparation and nasogastric tubes have been excluded.

A 2016 systematic review highlighted a need for further studies to identify benefits for thoracic surgical patients [38]. Recent publications have shown benefits for lung cancer patients undergoing surgery with reduced length of hospital stay [39-41], reduction in surgical complications [39,41], reduced ITU admission [40,41] whilst being cost effective [39,40]. A further systematic review, comprising data from seven RCTs indicated ER patients had significantly lower morbidity rates, surgical complications rates, shortened hospital stay, ITU stay and reduced costs [42].

However, at the time of writing, there are no definitively published recommendations or consensus opinion into the exact elements that make up a thoracic surgery specific ER programme.

1.5 Quality improvement in healthcare

The advantages of ER in colorectal surgery have been demonstrated and guidelines established. Thus, the implementation of an ER pathway into other surgical

specialities (e.g. thoracic surgery) should improve the quality of healthcare for patients undergoing non-colorectal surgery.

Improving the quality of healthcare for patients will lead to better patient experience and outcomes. This can be achieved by employing a systematic approach to implementing change and monitoring subsequent progress. There are several approaches to delivering quality improvement, some borrowed from industry, but all have several underlying principles [43].

- Data and measurement for improvement: gathering data is key to measuring and improving quality
- Understanding the process: process mapping can be used to identify and quantify problems
- Improving reliability: ensuring reliability reduces error
- Engagement of staff: changes to pathways or care is difficult without engagement of staff delivering that service, engagement with change is vital
- Involving patients: patients have a role to play in designing improvements and also monitoring the impact of changes to healthcare

For patients undergoing treatment within the NHS, a five-step improvement approach has been designed by NHS Improvements [44]. The five steps of each project should include the following phases:

1. Preparation- defining aims and objectives, collecting baseline data, identifying team and direction of planned work

2. Launch- start of project

3.Diagnosis- understanding the current process, using data to define the problem

4.Implementation- tests and measures potential solutions

5.Evaluation- learning from process and incorporating improvement into normal practice

In conjunction with the Model of Improvement [Fig 2], these steps are designed to provide a framework for implementing change that leads to improvement.

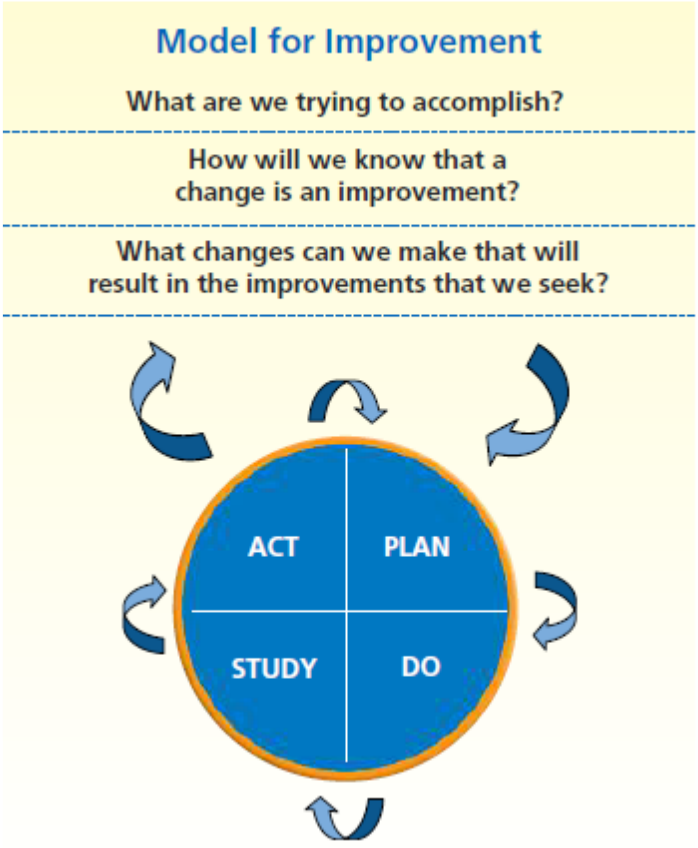


Figure 2: Model of Improvement [44].

1.6 Measuring improvement

Using the model of improvement the steps for this project include:

PLAN: Review of literature

DO: Gap analyses, units visits, national survey

STUDY: Measure outcomes to evaluate pathway

ACT: Construct ER pathway in thoracic surgery for potential national dissemination

It is essential to measure outcomes to demonstrate whether any change is an improvement, or otherwise. Measures that demonstrate change in the literature are usually quantitative. Reported outcome measures for ER programmes focus on mortality, complications rates, length of hospital stay and readmission rates. Much less emphasis is placed on qualitative patient data, for example quality of life measurement, patient experience or acceptability of an ER pathway or individual elements within a programme. Data collection for this project will focus on quantitative outcome measures to assess the initial impact of ER- mortality, length of stay and post-operative pulmonary complication rates.

2 MATERIALS & METHODS

Project aim:

> This project aims to develop a thoracic focused enhanced recovery programme from the principles set out in the ‘Delivering enhanced recovery’ document [2] and test the impact of its introduction

2.1 Review of the literature

- Key questions identified
- Literature reviews of key questions

The original ERAS pathway was devised for colorectal surgery and thus not all elements are applicable to thoracic surgery. Examination of the pathway (Figure 1) revealed various elements (e.g. bowel preparation, nasogastric tubes and wound drains) that are not routine practice in thoracic surgery. Thus, these were discarded from consideration for review. Furthermore, some aspects of routine thoracic surgical practice do not figure on the ERAS pathway but are important factors to consider. These include chest drain management and post-operative physiotherapy and mobilisation. A list of the 10 most important questions to consider was devised by the PGR and Lead-Supervisor (Table 1). This list is included below and includes the two questions (*) taken forward.

Table 1: Initial 10 questions/areas for research considered for literature review

PRE-OPERATIVE	PERI-OPERATIVE	POST-OPERATIVE
Patient pre-rehabilitation	Day of surgery admission	Early mobilisation
Patient information and education	Starvation and dehydration	Digital drains/drain management*
Pre-operative optimisation	Carbohydrate loading*	
	Anaesthetic techniques and/or analgesia protocol	
	Avoiding fluid overload	

Two research questions to be taken forward for literature review:

1) Chest drain management – information regarding underwater seals and digital drainage systems, threshold levels for chest drain removal, drain management, number of chest drains and the application of suction (to the chest drain) would be investigated.
2) Carbohydrate loading – effects of pre-operative oral carbohydrate loading drinks on patient outcomes would be evaluated.

2.1.1 Search strategies

2.1.1.1 Chest drain management

Literature search was conducted in February 2012 utilising MEDLINE, Embase and Cochrane databases to identify publications between 2000 and 2012. Medical subject headings terms were used, key words included chest tubes, thoracostomy,

thorax drainage, surgery, fast track and enhanced recovery and were combined using operations AND and OR. Publications were limited to human subjects and English language. The search strategy excluded studies in non-thoracic surgical patients (e.g. patients with respiratory disease), non-lung cancer patients, children or adolescent subjects and animal studies. Duplicate publications were excluded. For each relevant paper identified the abstract was obtained and reviewed by the PGR before inclusion or exclusion. Studies containing outcome measures comparing underwater seals and digital drainage systems, threshold levels for chest drain removal, drain management, number of chest drains and the application of suction (to the chest drain) were retained to answer the research question. The references from relevant articles were searched for additional publications.

2.1.1.2 Carbohydrate loading

Studies published between 2000 and 2012 were searched in MEDLINE, Embase and Cochrane databases when the literature search for this research question was undertaken in March 2012. Relevant articles were identified using the search terms preoperative care, energy drink, carbohydrate, dietary supplements and surgical patient in combination. The search utilised AND and OR operations and was limited to human subjects and English language. Duplicates were also excluded, along with studies involving non-surgical patients, non-adult patients and animal subjects. For each paper identified the abstract was obtained and reviewed by the PGR. The full article was obtained for relevant abstracts and the remainder discarded. Full articles were appraised in relation to answering the research question evaluating the effect of

pre-operative oral carbohydrate loading drinks on patient outcomes. A bibliography search of retained articles was also performed to obtain further relevant papers.

2.2 Gap analysis

- Thoracic surgical unit visits and gap analysis of each
- Current enhanced recovery pathways evaluated
- Assimilation of best practice into local protocols

Three units undertaking thoracic surgery were visited as part of this thesis (Liverpool Heart & Chest Hospital, University Hospitals South Manchester and Bristol Royal Infirmary). Gap analysis of each unit's ERAS pathway was undertaken (for each unit). Information was collated on the data collection template (Table 2).

The data collection template was derived from the established colorectal ER pathway [2]. Each element within the three stages [pre-, peri- and post-operative] of the pathway was included. Exceptions removed from the template included elements not associated with established thoracic surgical practice. For example, the routine use of NGTs and pre-operative bowel preparation does not form part of routine thoracic surgical practice. These were thus removed.

The gap analysis was designed to elicit the elements of ER being practiced at other thoracic surgical institutions, to instruct formulation of our own pathway. Due to the

small number of interviews conducted and the informal nature of these discussions, formal qualitative analysis of the data obtained was not intended.

Table 2: Gap analysis template [2]

Elements	Practice status	Notes / actions	Responsibility
Getting the patient in best possible condition			
Primary Care Input			
Optimising Haemoglobin levels			
Managing pre-existing co morbidities e.g. Diabetes/Hypertension			
Pre-operative			
Health and Risk Assessment			
Good Quality Patient Information			
Informed decision making			
Managing patient's expectations			
Optimised health/medical condition			
Therapy Advice			
Carbohydrate loaded drinks (high energy drinks)			
Maximising patients hydration			
Discharge Planning – expected date of discharge (EDD)			
Admission			
Admit on day of surgery			
Optimise fluid hydration			
Avoid routine use of sedative pre-medication			
Carbohydrate loaded drinks (high energy drinks)			
The patient has the best possible management during surgery			
Intra-operative			
Minimally invasive surgery if possible			
Individualised goal-directed fluid therapy			
Avoid crystalloid overload			
Epidural management			
Use of regional/spinal and local anaesthetic with sedation			
Hypothermia prevention			

The patient experiences the best post-operative rehabilitation

Post Operative			
No routine use of wound drains			
Chest drain management			
Active planned mobilisation <24 hrs			
Early oral hydration			
Early oral nutrition			
IV therapy stopped early			
Catheters removed early			
Regular oral analgesia e.g. paracetamol and NSAIDS			
Avoidance of systemic opiate-based analgesia where possible			
Follow-up			
Discharge on planned day or when criteria met			
Therapy support (Physio, Dietician)			
24 hour telephone follow-up call if appropriate			

2.3 National survey

- *Survey construction*

The survey was constructed by the PGR and Lead-supervisor. Questions were derived to elicit information regarding the key elements of ER as defined by the review of the literature and by responses captured in the gap analysis. These were defined as pre-operative assessment, patient information, day of surgery admission, starvation instructions, the use of minimally invasive surgery, post-operative analgesia, physiotherapy input and post-discharge from hospital advice. The survey underwent a number of revisions to ensure ease of use after review from key stakeholders including surgeons, anaesthetists, nursing staff, physiotherapists and lung cancer nurse specialists It was subsequently trialled at Heart of England NHS Foundation Trust before national dissemination (Figure 3).

Figure 3: The questions posed in the survey of ER implementation. The majority of questions were yes/no. In some instances there were several fixed options to choose from.

Authors: Mr R Wotton, Mr B Naidu

DEMOGRAPHICS

1. Which unit do you work in?
2. What is your profession?

PRE-OPERATIVE ASSESSMENT

3. Do your elective thoracic (lung) surgery patients go through a Pre-operative assessment clinic (POAC)?
4. If yes, what percentage of patients go through POAC?
5. If yes, is an anaesthetist available to review patients in POAC?
6. How do you believe a POAC benefits your patient?

PATIENT INFORMATION

7. Does each patient receive thoracic surgery-specific information?
8. If yes, in what form does this take?
9. How do you rate the information your unit gives to patients?

DAY OF SURGERY (DOS) ADMISSION

10. Are all elective thoracic (lung) patients admitted on DOS?
11. If yes, what percentage are admitted on DOS?
12. Are there any groups of patients not admitted DOS?
13. Are there any other barriers to implementing DOS admission?

PERI-OPERATIVE PROCEDURES

14. How long before surgery are your patients NBM for fluid?

15. How long do you think your patients should be NBM for fluid pre-operatively?

16. How long before surgery are your patients NBM for food?

17. How long do you think that your patients should be NBM for food pre-operatively?

18. Does your unit perform minimally invasive (VATS) surgery for major lung resections?

19. If yes, have you observed improvements in: pain scores/complication rates/patient satisfaction/LOS/other?

20. For major lung resections, for pain management, do you use: epidurals/PVC/intrathecal injections/IV morphine/other?

21. What percentage of patients have a PVC for pain management?

22. Where do your routine major lung resections go from theatre?

POST-OPERATIVE PROCEDURES

23. Does your unit have a standardised post-operative analgesia guideline?

24. Is it a thoracic-specific written protocol?

25. Do your analgesia guidelines include regular use of laxatives?

26. Do your analgesia guidelines include regular use of NSAIDs?

27. Does your unit have a standardised post-operative physiotherapy protocol?

28. Is it a thoracic-specific written protocol?

29. Are all patients with major lung resections sat out in a chair on post-operative day 1?

30. Do you think sitting patients out in a chair on post-operative day 1 is best practice?

31. Are all patients with major lung resections mobilised on post-operative day 1?

32. Do you think mobilising patients on post-operative day 1 is best practice?

DISCHARGE & FOLLOW UP

33. Are all your patients given thoracic-specific post-discharge advice before going home?
34. If yes, in what form does this take?
35. Does your unit routinely contact patients after discharge before they are reviewed as an outpatient?
36. If yes, when does this usually occur?
37. If yes, what form does this take?
38. How you think post discharge contact would benefit patients?

A survey comprising 38 questions was sent to all thoracic surgical units (n=40) in the UK regarding implementation of ER. Questions were designed to survey the current practice and implementation of key ER elements as defined by national guidelines. Opinions of practice were also sought from key individuals caring for thoracic surgical patients from each thoracic unit with in the UK.

- *Recipient identification via national society database/direct contact with each thoracic surgical unit/email address identification on internet*

We then invited the key members of all the UK thoracic surgical Units (n= 40) to participate in the survey. For each unit, the opinions of surgeons, physiotherapists, ward nursing staff, and lung cancer specialist nurses were gathered. Responders were identified from a variety of sources including the professional bodies (Society for Cardiothoracic Surgery in Great Britain & Ireland, The National Lung Cancer

Forum for Nurses and The Chartered Society of Physiotherapy), the National Thoracic Surgery Activity & Outcomes Report [45] and information publically available on the internet. The aim was to encompass as wide a spectrum of opinions as possible, from a variety of healthcare professionals caring for thoracic surgical patients. The survey was completed online from a commercially available provider (www.surveymonkey.com). Individuals were invited to complete only once and responses were collected anonymously.

- *NHS Improvement involvement for survey distribution*

We sought advice from the NHS Improvements (now part of NHS IQ) on the questionnaire construction and clarity of survey design.

- *Collation of results*

Results were collated by NHS Improvement and conveyed to PGR and Lead-supervisor

- *Dissemination of information at national meeting*

Presented at ERAS in thoracic surgery session entitled "*Enhanced Recovery: Fulfilling the potential a better journey for patients and a better deal for the NHS*" at Society for Cardiothoracic Surgery of Great Britain & Ireland, Annual Meeting 2013 [Appendix 1].

2.4 Enhanced recovery pathway development

2.4.1 Enhanced recovery pathway at Heartlands

Enhanced recovery guidelines were devised by PGR and Lead supervisor from best available research evidence (colorectal literature and literature review) and current ER practice (gap analysis) [Figure 4]. Collation of these results resulted in the construction of the Enhanced recovery in thoracic surgery manual.

This was disseminated for comment and amendment by key stakeholders within Heartlands hospital. Opinions were sought from staff including (but not limited to) surgeons, anaesthetists, nursing staff, lung cancer nurse specialists, physiotherapists, pre-operative admission clinic staff and surgical admission suite staff. Feedback was incorporated into the manual before final construction and publication [Appendix 2].

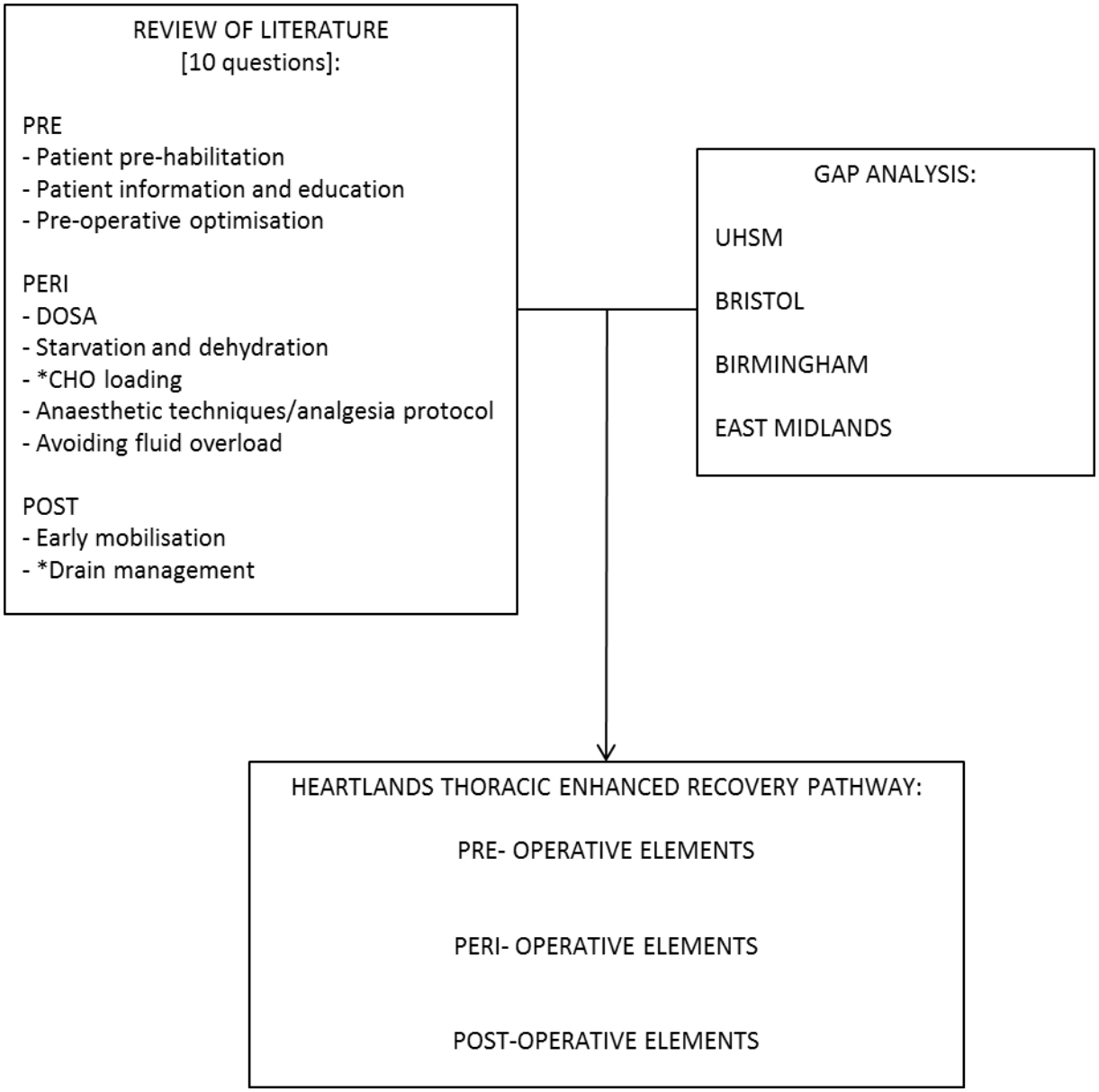


Figure 4: Flow diagram of Heartlands ER pathway design

2.4.2 The electronic prescription of a standardised pain control pathway

At Birmingham Heartlands Hospital patient's medications are prescribed electronically. This had previously led to the introduction of thoracic surgical electronic prescription (EP) bundles. These included medications for analgesia, anti-emetics, laxatives, gastric protection, nebulisers and oxygen (Figure 5).

Drug group	VATS (non-lobectomy) prescription bundle	Thoracotomy prescription bundle
Analgesics	Paracetamol 1g QDS PO	Paracetamol 1g QDS PO
	Ibuprofen 400mg TDS PO*	Codeine 60mg PRN QDS PO
	Codeine 60mg PRN QDS PO	
	Morphine sulphate solution 10mg hourly PRN PO	Morphine sulphate solution 10mg hourly PRN PO
Anti-emetics	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV
	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV
Laxatives	Docusate Sodium 100mg PRN TDS PO	Docusate Sodium 100mg PRN TDS PO
	Senna 15mg PRN Nocte PO	Senna 15mg PRN Nocte PO
	Macrogol 1 sachet PRN TDS PO	Macrogol 1 sachet PRN TDS PO
Gastro-protection	Omeprazole 20mg OD	
Nebulisers	0.9% Salbutamol 2.5mg QDS NEB	0.9% Salbutamol 2.5mg QDS NEB
	0.9% Saline 5ml 2h PRN NEB	0.9% Saline 5ml 2h PRN NEB
Respiratory depression	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)
	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)

Figure 5: Original thoracic EP bundles (Authors: Mr C Bond, Mr R Wotton, Mr B Naidu)

However, these needed revising to ensure regular prescription of anti-emetics and laxatives to improve inpatient experience and reduce delayed discharge. Further modification to the bundles was proposed (Appendix 3).

2.4.3 Minimising dehydration

One of the key elements of ER is fluid management by maintaining good pre-operative hydration. One simple strategy to minimise dehydration prior to surgery is to inform patients about taking oral fluids prior to their operation. By instructing patient about when exactly to take oral fluids it is hoped that dehydration can be avoided. This was done by reworking the patient admission letter with details of when the patient should have a drink. The admission letter was changed from:

…You must ensure that you have nothing to eat or drink after 3.00 am on the day of your admission as your operation will be performed later on that day. You may have water until 7.00am, no gums/mints/sweets…

to

…You must ensure that you have nothing to eat after 3.00 am on the day of your admission. Please drink two large glasses of water (at least 500ml) before 7.00am the morning of your surgery. Please don't have anything to drink after 7.00am. No chewing gum, mints or sweets…

By giving clear instructions to drink fluid on the morning of surgery it is hoped that patients are not dehydrated at time of operation

2.4.4 Patient information

Another element important in any ER pathway is the provision of good quality patient information. The construction of a new patient information booklet was deemed essential to provide up to date, accurate for our own unit. Thus, drawing on the experience of visiting other units, evaluating their and our own patient information, alongside discussions with patients, ‘My Lung Surgery Handbook’ was constructed [Appendix 4]. This patient information booklet is currently in production and will shortly be distributed to lung surgery patients.

2.5 Testing the pathway

The ERAS programme was initiated at Birmingham Heartlands Hospital in February 2013. The impact of this pathway will be assessed by a retrospective audit of outcomes for patients with primary lung cancer undergoing single pulmonary lobectomy. Patients will undergo lobectomy either by thoracotomy or VATS surgical approaches. Patients excluded from the analysis will include, those undergoing pulmonary bilobectomy, sleeve lobectomy, conversions from VATS to thoracotomy, redo-thoracotomy and those who had a lobectomy for non-primary lung cancer [e.g. benign disease or metastectomy].

Data evaluating the impact of ERAS will be obtained for one prior to, and three years after the programme’s introduction.

Patient demographics including age, sex, BMI and pre-operative FEV1 were collected. In addition, total number of cases per surgical approach and the outcome measures of number of deaths, length of hospital stay [LOS] and post-operative

pulmonary complications [PPC] rate were analysed. A PPC was defined as any patient having four, or more, of the following eight clinical, biochemical or radiological criteria [CXR showing evidence of atelectasis or consolidation; elevated serum WCC >11.2; oxygen saturations <90% on room air; purulent sputum; raised body temperature >38^{o}C; microbiology reported sputum sample positive for infection; physician diagnosis of lower respiratory tract infection; readmission to HDU or ITU facilities] [46].

2.6 Data collection and analysis

The PGR inspected the citations independently and assessed each reference for possible inclusion. Full text articles were obtained and the final decision over inclusion was made by the PGR. The methodological quality was assessed using Cochrane Collaboration's tool for assessing risk of bias [47]. Data for age, BMI and FEV1 are presented as mean and standard deviations [SD], whilst median with interquartile range [IQR, 25th and 75th quartiles] are used for LOS. Statistical analysis package within Microsoft Excel was employed to analyse the data.

3 RESULTS

3.1 Review of the literature

- Literature review questions

    1. Chest drain management

    2. Carbohydrate loading

3.1.1 *Question 1- Chest drain management*

The question addressed the management of chest drains following thoracic surgery. A total of 291 papers were found using the reported literature searches, of which 12 represented the best evidence to answer the questions. Two papers were found by bibliography searching. Figure 6 represents the selection of studies for chest drain management. Details of the search strategy for chest drain management are included in Appendix 5.

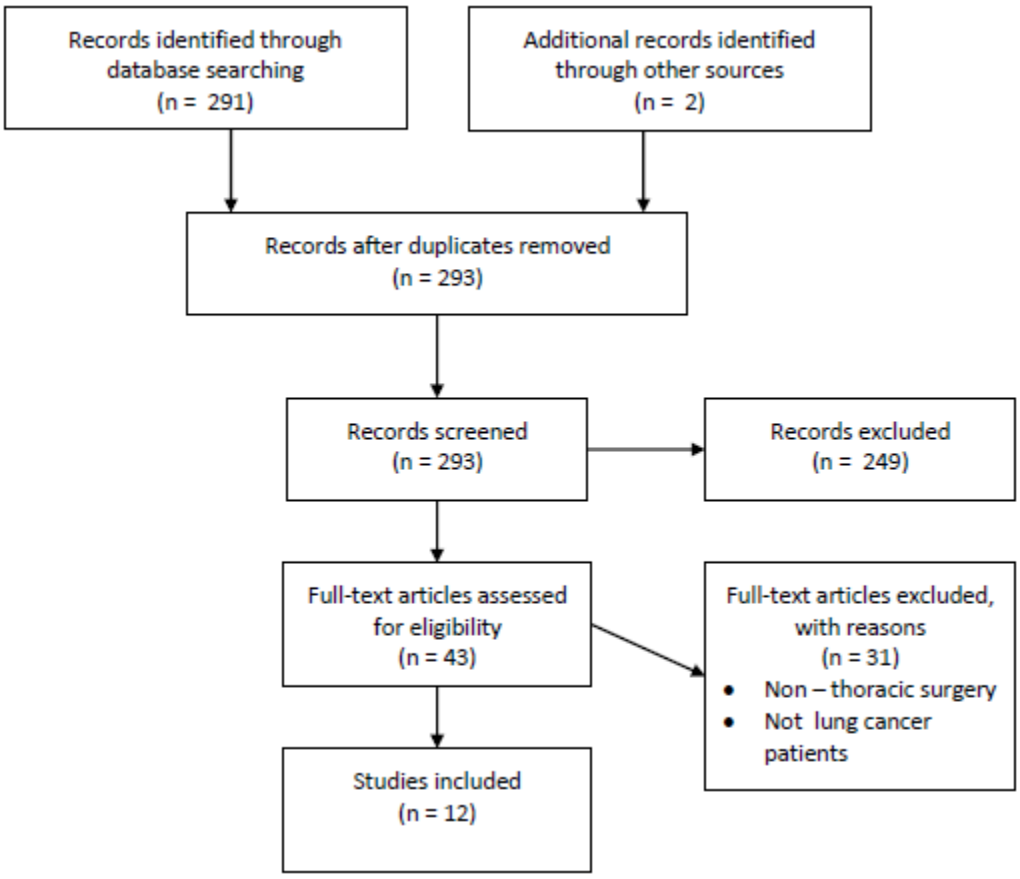


Figure 6: Selection of studies – chest drain management

The authors, date, journal, study type, population, main outcome measures and results were tabulated. A number of practices regarding the management of chest drains following thoracic surgery were addressed, including the use of digital drains, drain removal threshold, the use of drain management protocols, manipulating intercostal drains after surgery, the number of drains placed and the routine use of suction (Table 3).

Table 3: Summary of evidence for management of chest drains

Study	Outcomes	Key results
DIGITAL v UNDERWATER SEAL DRAINAGE SYSTEMS		
Brunelli et al. 2010 [48]	Chest tube duration	Mean ICD duration reduced with digital monitoring 4.0 vs 4.9 days (p=0.0007)
	Hospital stay	Reduced hospital stay in digital monitoring group: 5.4 vs 6.3 days (p=0.007)
	Cost	Cost saving of €476 per patient (p=0.008) with digital monitor (€2391 vs €2867)
Filosso et al. 2010 [49]	First drainage (tube) removal day	Earlier removal in digital group 33% vs 6% on day1 (digital 5 pts v traditional 1pt protocols) for first drain (p=0.001)
	Second drainage (tube) removal day	Earlier in digital group (graph data only) (p=0.005)
	Hospital LOS	Reduced in digital group (graph data only) (p=0.00001)
	Overall hospitalisation cost	Reduced in digital group (graph data only) (p=0.00005)
Varela et al. 2009 [50]	Inter-observer variability: traditional group	High rate of disagreement (overall kappa coefficient 0.37)
	Inter-observer variability: digital group	High rate of agreement (kappa coefficient 0.88)
DRAINAGE REMOVAL THRESHOLD		
Hessami et al. 2009 [51]	LOS	Reduced in trial group 4.1±1.8 vs 4.8±1.7 control (p=0.04)
	Drainage time	No difference: Trial 3.4±1.6 vs 3.8±1.5 control (p=0.1)
	Radiologic re-accumulation	No difference: Trial 8.8 vs 7.1 control (p=0.62)
	Thoracocentesis (Need for)	No difference: Trial 4.3 vs 4.3 control (p=0.97)
	Decrease pulmonary sound	No difference: Trial 4.4 vs 5.7 control (p=0.72)
DRAIN MANAGEMENT PROTOCOL		
Martin-Ucar et al. 2003 [52]	Compliance	95% (94 patients) with protocol
	Complications	Low- 3% ICD re-insertion rate
MANIPULATING INTERCOSTAL DRAINS		
Dango et al. 2010 [53]	30-day mortality	No statistical difference: Milking 1.4% vs 1.4% trad (p=0.74).
	30-day morbidity	No statistical difference: Milking 49% vs 53% trad (p=0.41).
	Postoperative fluid drainage	Increased in milking group at 12h (p=0.03), 24h (p=0.01), 48h (p=0.004) post operatively than in observation group. At 2h and total drainage did not differ significantly.
	Duration of chest drainage	No statistical difference (No data)
	Quality of effusion	No statistical difference (No data)
	Postoperative air leakage	No statistical difference: Milking 64% vs 65% Observation (p=0.31)
	LOS (days)	No statistical difference: Milking 13.4 days vs 13.2 days (p=0.74)
INTERCOSTAL DRAINS: ONE vs TWO		
Okur et al. 2009 [54]	Total pleural drainage (cc)	Reduced in single ICD patients 600±43cc vs 896±56 cc [double tube] (p<0.001)

	'Early' and 'late' postoperative pain (1-10)	Both reduced in single ICD group: Early- 4.28±0.21 vs 5.10±0.23 [double tube] (p=0.014); Late- 1.48±0.13 vs 2.00±0.17 [double tube] (p=0.01)
	Duration of chest tube drainage (day)	Shorter in single group (not significant): 3.38±1.36 vs 3.90±1.46 [double tube] (p=0.069)
	LOS	Shorter in single ICD group (not significant): 4.84±1.20 vs 5.20±1.38 [double tube] (p=0.17)
	Complication rate	No difference: Single 13 patients vs 16 patients double tube (p=0.50)
Dawson et al. 2010 [55]	Postoperative pain	Reduced with one ICD
	Lower use of non-standard analgesia, with no difference in total pain score.	One ICD
	Shorter duration of opioids and NSAIDs	One ICD
	Duration and amount of drainage	No difference
	LOS	No difference
INTERCOSTAL DRAINS: ONE vs NONE		
Luckraz et al. 2007 [56]	Day 1 postoperative pain scores	No significant difference: median score 5 (with ICD) vs 5 (no ICD) (p=0.81)
	Wound complications	No difference (no data)
	Significant PTX	No difference (no data)
	Small, clinically not significant (size <10%) PTX	28% (with ICD) vs 15% (no ICD) (p=0.24)
	LOS	Median LOS: 3 (with ICD) vs 1 (no ICD) day (p<0.001)
Koc et al. 2010 [57]	No air leak	No ICD favoured- reduced LOS, complications
SUCTION vs NO SUCTION		
Sanni et al. 2006 [58]	Reduction in incidence of air leak	Evidence favours underwater seal over suction.
Prokakis et al. 2008 [59]	Time between removal of first and second ICDs (mean)	No difference: Suction 1.9 and 3.1days vs 1.5 and 3days [no suction] (p>0.05)
	Mortality (No. deaths)	No difference: 1 (suction) vs 3 (no suction) groups (p>0.05)
	Morbidity	No difference (p>0.05)
	Adequacy of drainage	No difference: Suction 94% vs 88.6% [no suction] (p>0.05)
	LOS (mean ± SD)	No difference: Suction group 11.2 ±5.4 vs 10.3±4.5 [no suction] (p>0.05)

Studies were also examined for possible sources of bias, but the wide variety of chest drain management practices between scientific papers prevented further evaluation in the form of a meta-analysis (Table 4).

Study	Year	Study type	Participants (n)	Potential sources of bias
Brunelli [48]	2010	RCT	159	Unblinded – performance and detection bias
Filosso [49]	2010	RCT	31	Unblinded – performance and detection bias
Varela [50]	2009	RCT	61	Unblinded – performance and detection bias
Hessami [51]	2009	RCT	138	Not randomised – selection bias
Martin-Ucar [52]	2003	Cohort study	99	Performance bias
Dango [53]	2010	Cohort study	145	Not randomised – selection bias
Okur [54]	2009	RCT	100	Unblinded – performance and detection bias Not randomised – selection bias
Dawson [55]	2010	Best evidence topic	660	Possible reporting bias
Luckraz [56]	2007	RCT	37	Selection bias due to small sample size
Koc [57]	2010	Best evidence topic	974	Possible reporting bias
Sanni [58]	2006	Best evidence topic	694	Possible reporting bias
Prokakis [59]	2008	RCT	91	Unclear

Table 4: Study design and bias assessment – chest drain management

DIGITAL v UNDERWATER SEAL DRAINAGE SYSTEMS

Digital drainage system – drainage system encompassing a digital display showing current and long-term air leak, built in suction and fluid collection cannister, in one portable unit.

Underwater seal – drainage system comprising chamber(s) with water seal and drainage collection chamber.

Brunelli et al. [48] conducted a prospective randomised trial to compare digital chest drain system and traditional underwater seal. One hundred and sixty-six patients undergoing pulmonary lobectomy were included. Chest tube duration, length of hospital stay and cost were the endpoints evaluated. Mean chest tube duration was reduced with digital chest drain system to 4.0 from 4.9 days (p=0.0007). Further advantages in reduced length of stay (5.4 v 6.3 days; p=0.007) and cost saving (€476/patient; p=0.008) were observed in patients using digital drainage monitors.

Filosso et al. [49] performed pulmonary lobectomies on 31 patients with moderate COPD for primary lung cancer. A digital chest drainage system was compared to traditional underwater seal. Removal of drainage tubes was earlier in the digital system group with first drain removed on day 1 in 33% digital group v 6% traditional group (p=0.001) and second drainage tube also removed earlier (graph data; p=0.005). Patients in digital system group also had a shortened in-hospital length of

stay (graph data; p=0.00001) with a concurrently overall lower hospitalisation cost (graph data; p=0.00005).

Varela et al. [50] undertook a prospective randomised trial comparing digital chest drainage system to traditional underwater seal in 61 patients undergoing pulmonary resection (not including pneumonectomy). Inter-observer variability in air leak measurement in deciding chest tube removal was evaluated. A high rate of disagreement (overall kappa coefficient 0.37) was observed in the traditional drainage system group. In contrast, in the digital system group there was a high rate of agreement (kappa coefficient 0.88) in deciding chest tube removal.

DRAINAGE REMOVAL THRESHOLD

Hessami et al. [51] compared chest drain output of 150ml/day and 200ml/day in 138 patients requiring an intercostal drain for trauma or malignancy. Endpoints included length of hospital stay, drainage time, radiological evidence of re-accumulation, need for thoracocentesis and decreased pulmonary sound. Length of stay was reduced in the trial group: 4.1±1.8 days vs. 4.8±1.7 days in the control group (p=0.04). All other endpoints showed no significant difference between the two groups. The authors conclude using a daily drainage threshold of 200ml safely decreases LOS.

Other studies have used a variety of different drainage thresholds: 200ml/day [48, 49, 52, 58], 250ml/day [50, 53], 400ml/24hrs [51] without documented complication.

DRAIN MANAGEMENT PROTOCOL

Martin-Ucar et al. [52] conducted an institutional review of implementation of a drain management protocol to test compliance and complication rate. The authors concluded that the protocol can be implemented with high-compliance and low complications.

DRAIN MANIPULATION

Dango et al. [53] investigated the effect of chest drain ‘milking’ (1 minute every 2 hours for first 48 hours) in 145 patients undergoing pulmonary resection via thoracotomy. Endpoints measured included 30-day morbidity and mortality, post-operative fluid drainage, duration of chest drainage, quality of effusion, post-operative air leak and length of hospital stay. ‘Milking’ or drain manipulation did not adversely affect 30-day mortality ($p=0.74$) or 30-day morbidity ($p=0.41$). It did significantly increase post-operative drainage at 12 hours ($p=0.03$), 24 hours ($p=0.01$) and 48 hours ($p=0.004$) after surgery. Total drainage, and drainage at 2 hours post procedure, did not differ. There was no statistical difference between drain manipulation and observation group in terms of duration of chest drainage and quality of effusion (data not presented). There was also no statistical difference in post-operative air leak ($p=0.31$) and length of stay ($p=0.74$) between the two arms of the study. The authors concluded that post-operative morbidity and mortality was not improved with milking and should therefore not be recommended.

NUMBER OF DRAINS: 2 vs 1

Okur et al. [54] undertook a prospective randomised study in 100 consecutive lobectomy or bi-lobectomy patients to investigate whether two chest tubes were more effective than one. Total pleural drainage, ‘early’ and ‘late’ post-operative pain, duration of chest tube drainage, length of hospital stay and complication rates were evaluated. Pleural drainage was reduced in single ICD patients 600±43cc vs 896±56 cc [double tube] ($p<0.001$). Using only one ICD also conveyed advantages in reducing ‘early’ ($p=0.014$) and ‘late’ ($p=0.01$) post-operative pain. Duration of chest drainage was shorter in single ICD group, but not significantly, 3.38±1.36 days [single tube] vs 3.90±1.46 days [double tube] ($p=0.069$). Length of stay was shorter, although not significantly ($p=0.17$) in the single ICD group. Complication rates were not significantly different between the two groups ($p=0.50$). The authors conclude inserting two ICDs is no more effective than one, after standard lobectomy. Placing one ICD results in less postoperative pain and pleural fluid loss, without increasing complication rates.

Dawson et al. [55] conducted a best evidence topic comparing one with two ICDs following lobectomy. This mini-systematic review concluded two drains were not superior to one, may cause more pain and be more expensive. A single ICD conveyed advantages in terms of lower use of non-standard analgesia with shorter duration of opioid and NSAID use.

NUMBER OF DRAINS: 1 vs 0

Luckraz et al. [56] reported a prospective randomised trial in 60 patients placing either one or no ICD following VATS lung biopsy. There was no air leak at the end of the procedure. There was no significant difference in day 1 post-operative pain scores ($p=0.81$). There was no reported difference in wound complications or significant pneumothorax (no data) post procedure. Small, clinically insignificant, pneumothoraces were observed in both groups, 28% with ICD and 15% without ICD ($p=0.24$). Length of stay was significantly reduced in patients without ICD, 1 day vs 3 days with ICD ($p<0.001$). At 6 weeks all patients had fully expanded lungs. The authors conclude that there is no need for ICD in patients undergoing VATS lung biopsy with no air leak at time of surgery.

Koc et al. [57] undertook a best evidence topic comparing one to no ICD post VATS lung biopsy in patients without intra-operative air leak. The results of this mini-systematic review favoured not placing an ICD, as it conveyed advantages of reduced length of stay and complication rate. The authors comment that where no air leak is detected intra-operatively, no ICD should be placed for patients undergoing VATS lung biopsy.

SUCTION vs NO SUCTION

Sanni et al. [58] report a best evidence topic comparing application of suction to underwater seal post lobectomy. The evidence favours underwater seal over suction

to reduce the incidence of air leak. Some studies used short term suction in the immediate post-operative period, with no difference in outcome. The exceptions to this may be patients with large air leaks or large PTX.

Prokakis et al. [59] undertook a prospective randomised trial comparing active suction (-15 to -20 cmH_2O) applied to underwater seal to no suction. The study included 91 patients undergoing lobectomy or bilobectomy for lung cancer. There was no statistical significant difference between the suction and non-suction groups for any of the following variables: time between removal of first and second ICDs, mortality, morbidity, adequacy of drainage and length of hospital stay. The authors conclude routine application of suction is not necessary. Suction may be useful in other settings (e.g. persistent PTX), but is no help when the lung is expanded.

3.1.2 *Question 2- Carbohydrate loading*

The question addressed the effect of carbohydrate (CHO) drink supplementation on patient outcomes following lung resection (non-oesophageal thoracic surgery). A total of 42 papers were found using the reported literature searches, and bibliography searching, of which 8 represented the best evidence to answer the question. No papers were found specifically addressing the question in thoracic surgery. Studies selected for analysis are included in figure 7, whilst the details of the search strategy are included in Appendix 5.

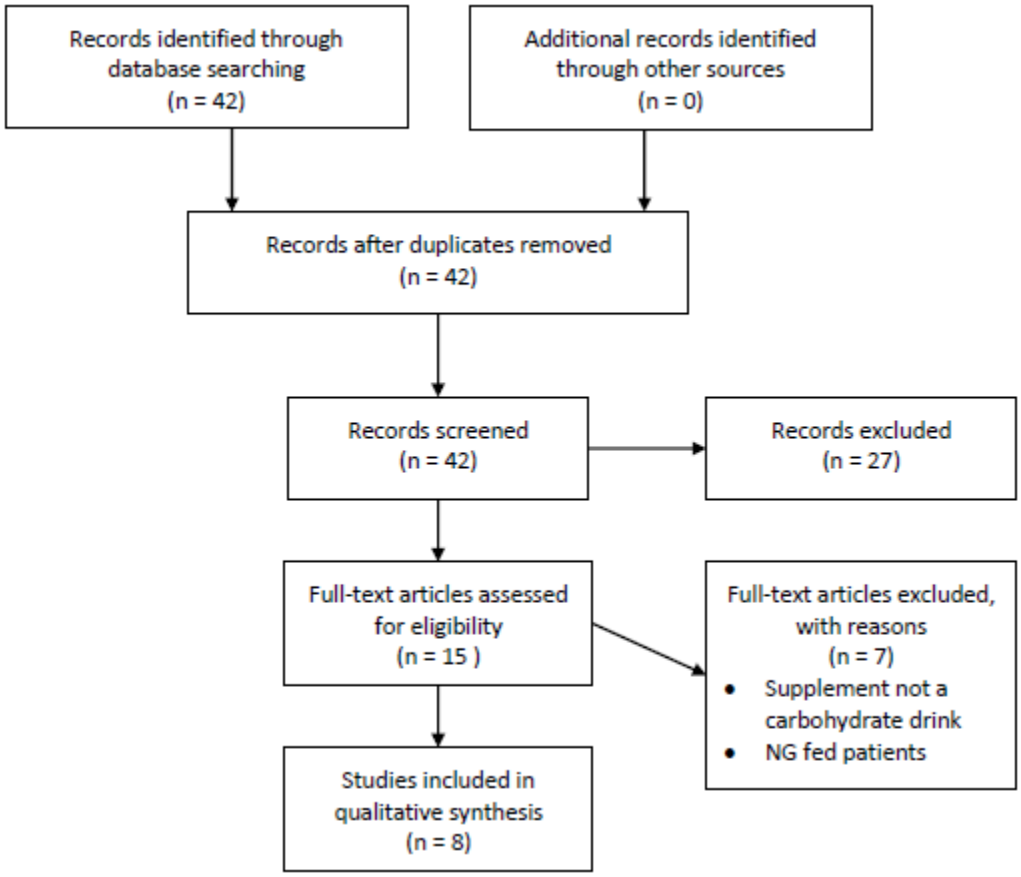


Figure 7: Selection of studies – carbohydrate loading

Evidence has been gathered from other surgical specialities. The authors, date, journal, study type, population, main outcome measures and results were tabulated. A number of prospective randomised control trials highlight the benefit of CHO drinks: reduced time to passage of first flatus/stool, improved grip strength, reduced post-operative muscle loss and reduced length of stay. The results from only a single study disagree with these advantages. In non-thoracic surgery, the use of CHO drinks appears to convey a number of advantages to patients undergoing elective surgery (Table 5).

Table 5: Summary of evidence for carbohydrate loading

Study	**Outcomes**	**Key result**
Hendry et al. 2010 [60]	Return of gastrointestinal function (passage of flatus/stool) [median (IQR)]	Overall median was 5 (4-6) days. CHO group: trend towards shorter time 4 (3-5) vs 5 (4-7) days (p=0.076). Laxative group: significantly reduced time 4 (3-5) vs 5 (4-6) days (p=0.034) Combination group: significantly reduced time 3 (3-4) vs 6 (4-7) days (p=0.013)
	Gastric emptying (isotope breath test day 3 post procedure)	Median post-operative gastric emptying was 0.74 (0.46-1.41) hours (No significant difference between groups; p-value not reported).
	Post-operative oral nutritional intake	Oral intake >50% of nutritional requirement- median 1 (1-2) days (No significant difference between groups; p-value not reported).
	Functional recovery	Median time to functional recovery was 4 (IQR 3-5) days (No significant difference between groups; p-value not reported).
	Morbidity	25% overall (No significant difference between groups; p-value not reported).
	LOS	Initial LOS median 6 (IQR 4-7) days (No significant difference between groups; p-value not reported).
Mathur et al. 2010 [61]	Fatigue (VAS score)	Significantly higher (p<0.005) in both groups on days 1-5 after surgery. No significant difference between two groups (p value not reported) Open surgery, no epidural: fatigue score dropped to baseline by day 3 (CHO), but still higher than baseline (p=0.008) on day 6 in placebo group (p=0.015 vs CHO group)
	Clinical outcomes	LOS, median (range): CHO 7 (2-35), placebo 8 (2-92); p=0.344 Open surgery without epidural CHO LOS 7 (3-11) and placebo 9 (2-48); p=0.054

		Postoperative infective complications: CHO (33%) vs placebo (41%); p=0.387
	Discomfort	Significantly higher than baseline in both groups on days 1-6 after surgery (p<0.007), but did not differ between groups (data not shown). By day 7 scores had returned to baseline
	Biochemistry	No significant differences in glucose, insulin and CRP between two groups on any day.
	Grip strength and mid-arm muscle circumference (MAMC)	Grip strength: Reduced on day 0 and over first week after surgery (p<0.10) in both groups. Return to baseline by day 28
	Total body protein (TBP)	TBP decreased after surgery in both groups (non-significant change)
Noblett et al. 2005 [62]	Time to first flatus	Median: 2 days (CHO) vs 3 days (water; p=0.13) vs 3 days (fasting ; p=0.13)
	First bowel movement	Median: 2 days (CHO) vs 3.5 days (fasting, p=0.2) vs 5 days (water, p=0.06)
	LOS	Median LOS: 7.5 days (CHO) vs 13 days (water; p=0.019) vs 10 days (fasting; p=0.06). Water vs fasting (p>0.25)
	Grip strength	Fasting group reduced post-operative grip strength (p<0.05). Median drop 10% at discharge in fasting group compared to 8% (water; p=0.7) and 5% (CHO; p=0.6)
Yuill et al. 2005 [63]	Loss of muscle mass (arm muscle circumference)	Significantly greater loss in control group (control: -1.1±0.15cm vs CHO: -0.5±0.16cm; p<0.05)
	Insulin control	Baseline insulin levels were comparable (control: 20.7±4.9mU/l vs CHO: 24.6±6.2mU/l). Did not differ post-operatively.
	Glucose control	Baseline glucose levels were comparable (control: 6.0±1.4mmol/l vs CHO: 5.7±1.4mU/l). Did not differ post-operatively.
	Morbidity	6 patients in each group.
	LOS	Median LOS in control group was 10 days (IQR=6) and 8 days in CHO group (not significantly different; no p-value reported).
Smedley et al. 2004 [64]	Post-operative change in body weight	Only patients in SS group gained weight pre-operatively, but also lost significantly less weight over course of study compared with CC or CS groups (p<0.05)
	Complications	Rate of major complications was similar in the four groups. Fewer minor complications in the SS and CS groups than in CC group (p<0.05)
	LOS	No significant differences (data not shown).
	Nutritional status	No significant differences (data not shown).
	QoL (Short Form 36, EuroQoL	No significant differences (data not shown).
	Cost of care	Overall costs in three supplemented groups less than no-supplemented group (approx. £300 or 15% per patient episode; not significant).
Brady et al. 2003 [65]	Shortened fluid fast	No evidence of increased risk of aspiration, regurgitation or related morbidity
	Volume of gastric contents	Water group had modest and clinically insignificant (6mls)
Hausel et al. 2001 [66]	Inability to concentrate	Increasing trend (p<0.05) in fasted and placebo groups from control to 90mins
	Malaise	Decreasing trend (p<0.01) in placebo and CHO groups from control to 90mins
	Nausea	Increasing trend (p<0.05) in placebo groups from control to 90mins
	Tiredness	Increasing trend (p<0.05) in fasted and placebo groups from control to 90mins

	Unfitness	Decreasing trend (p<0.01) in placebo and CHO groups from control to 90mins
	Weakness	Increasing trend (p<0.05) in fasted groups from control to 90mins
	Aspirated GFV, mL (median + IQR)	Lap. chole: CHO vs placebo vs fasted- No difference [18 (22-41) vs 20 (10-35) vs 24 (15-40)] MCS: CHO vs placebo vs fasted- No difference [2.1 (1.7-2.4) vs 1.9 (1.6-2.5) vs 2.0 (1.7-4.0)]
	Gastric pH (median + IQR)	Lap. chole: CHO vs placebo vs fasted- No difference [2.0 (1.6-2.7) vs 1.9 (1.8-2.3) vs 1.9 (1.6-2.3)] MCS: CHO vs placebo vs fasted- No difference [2.1 (1.7-2.4) vs 1.9 (1.6-2.5) vs 2.0 (1.7-4.0)]
	Drink related complications	No cases of pulmonary aspiration or other drink-related complications before, during or after surgery
	Hunger	Significant (p<0.05) reduction CHO vs fasting at 0,40,90mins post drink
	Thirst	Significant (p<0.05) reduction CHO vs fasting at 0,40,90mins post drink
	Anxiety	Significant (p<0.05) reduction CHO vs fasting at 0,40,90mins post drink
Macfie et al. 2000 [67]	Weight loss	Less weight loss in Group I than II, III or IV (not significant; p-value not reported)
	Mean serum albumin	Fall observed in mean perioperative serum albumin 5-8 g/L across four groups (not significant; p-value not reported)
	Mean mid-arm muscle circumference	No differences observed (p-value not reported)
	Mean hand grip strength	No differences observed (p-value not reported)
	Postoperative complications	No differences observed (p-value not reported)
	Mortality	No differences observed (p-value not reported)
	Hospital LOS	No differences observed (p-value not reported)
	HAD score	No differences observed (p-value not reported)

Table 6: Study design and bias assessment – carbohydrate loading

Study	Year	Study type	Participants (n)	Potential sources of bias
Hendry [60]	2010	RCT	68	No placebo available – study patients unblinded to intervention
Mathur [61]	2010	RCT	142	Variety of surgery procedures within trial– possible confounding Randomisation stratified to type of surgery
Noblett [62]	2005	RCT	36	Small sample size in each arm Study patients unblinded to intervention
Yuill [63]	2005	RCT	65	Method of randomisation unclear
Smedley [64]	2004	RCT	179	Study patients unblinded to intervention Method of randomisation unclear
Brady [65]	2003	Cochrane review	2270	
Hausel [66]	2001	RCT	252	Method of randomisation unclear Variety of surgery procedures within trial– possible confounding
Macfie [67]	2000	RCT	100	Unblinded trial Patients pre-selected in clinic – possible selection bias

Hendry et al. [60] conducted a prospective randomised control trial in 74 patients undergoing liver resection for benign and malignant disease. Patients were managed with an ERAS protocol and randomised to one of 4 study groups (1) Control (2) Laxatives (3) CHO drinks (4) Combination [laxatives + CHO drinks]. Endpoints included return of gastrointestinal function (passage of flatus/stool), gastric emptying (isotope breath test day 3 post procedure), time to post-operative oral nutritional intake, time to functional recovery, morbidity and LOS. Overall, the median return of gastrointestinal function was 5 (4-6) days. However, in the CHO group there was a trend towards shorter time; 4 (3-5) vs 5 (4-7) days (p=0.076). Similarly, for patients in the laxative group there was also significantly reduced time: 4 (3-5) vs 5 (4-6) days (p=0.034). The combination group also had a significantly reduced time of 3 (3-4) vs 6 (4-7) days (p=0.013) to passage of first stool. Median post-operative gastric emptying was 0.74 (0.46-1.41) hours (no significant difference between groups; p-value not reported). Time to oral nutritional intake of >50% of nutritional requirement was 1 (1-2) days (median [IQR] with no significant difference between groups. Median time to functional recovery was 4 (IQR 3-5) days (no significant difference between groups). The overall morbidity was 25% (no significant difference between groups). The median initial LOS was 6 (IQR 4-7) days (no significant difference between groups). The authors conclude that laxative and combination groups significantly decreased time to first passage of stool. There was no evidence of interaction between CHO drink and laxative. This study reports a significantly shorter median LOS as compared to other studies. Of note, the authors report no conflicts of interest, but the CHO drinks were provided by a pharmaceutical company in this study.

Mathur et al. [61] conducted a double blind randomised control trial comparing CHO drink with placebo in 142 patients undergoing elective colorectal or liver surgery. The prescription of a CHO drink was advantageous in reducing fatigue in patients having open surgery without epidural anaesthesia, but not comparing the overall groups. There was no statistical difference when comparing CHO drink to placebo in LOS, post-operative infectious complications, discomfort scores, biochemistry, grip strength, mid-arm muscle circumference and total body protein. The study was only powered to detect a 2-day reduction in LOS, which might account for the non-significant result. There were some differences in patient characteristics, the M:F ratios in the two arms of study were very different and the surgery included a heterogenous group of procedures. The participants also reported side effects of CHO drinks (29%) and placebo drink (10%) at different rates.

Noblett et al. [62] performed a randomised controlled trial comparing peri-operative CHO drink to water supplementation and fasting. Median time to first flatus was significantly reduced in favour of CHO drinks (2 days) when compared to water supplementation (3 days; p=0.13) and fasting (3 days; p=0.13). There was a non-significant trend towards earlier first bowel movement in CHO drink group (2 days) when compared to fasting (3.5 days; p=0.2) and water (5 days; p=0.06). LOS was significantly reduced in CHO group (7.5 days) when compared to water supplementation (13 days; p=0.019) and fasting (10 days; p= 0.06). There was no significant difference between the water and fasting groups (p>0.25). Complication rates varied between the three groups. In the fasting group, one complication was reported; diarrhoea and vomiting day 8 post procedure. In the water group there were

three complications, one perineal wound breakdown, one anastomotic leak and one prolonged ileus. In the CHO group, one patient suffered from prolonged nausea and one further patient developed symptomatic atrial fibrillation after omission of their prescribed B-blocker medication. Rate control was established with recommencement of their own medication.

Yuill et al. [63] conducted a double-blind randomised comparing peri-operative administration of CHO drink (12.6g/100ml) to placebo (control group). Sixty-five patients completed the study having undergone major, elective abdominal surgery. Endpoints measured included muscle mass (arm muscle circumference), insulin and glucose control, morbidity and LOS. There was significantly greater loss of muscle mass in control group (control: -1.1±0.15cm vs CHO: -0.5±0.16cm; $p<0.05$). Baseline insulin levels were comparable (control: 20.7±4.9mU/l vs CHO: 24.6±6.2mU/l) and levels did not differ post-operatively. Baseline glucose measurements were comparable (control: 6.0±1.4mmol/l vs CHO: 5.7±1.4mU/l) and did not differ post-operatively. Morbidity included 6 patients in each arm of the study. The median LOS in control group was 10 days (IQR=6) and 8 days in CHO group (not significantly different; no p-value reported).

Smedley et al. [64] conducted a two-phase randomised trial comparing the use of CHO drinks before and after surgery, in four groups (SS, SC, CS, CC; S=supplements, C=no supplements; taken in phases I & II). The primary endpoint was change in post-operative body weight. Only patients in SS group gained weight

pre-operatively, but also lost significantly less weight over the course of the study compared with CC or CS groups ($p<0.05$). Secondary endpoints included complication rate, LOS, nutritional status, QoL and cost of care. The rate of major complications was similar in the four groups. There were fewer minor complications in the SS and CS groups than in CC group ($p<0.05$). Overall costs in the three supplemented groups were less than in the no-supplemented group (approx. £300 or 15% per patient episode) but this saving was not statistically significant. Changes in LOS, nutritional status and QoL were not significant (data not shown). The authors conclude that the use of peri-operative CHO supplements has no disadvantages, leads to clinical benefit and is cost-effective in patients undergoing moderate to major lower gastrointestinal tract surgery.

Brady et al. [65] performed a Cochrane review of peri-operative fasting to prevent peri-operative complications. Fluids given up until 2 hours before surgery included CHO drinks. The authors conclude that shortening the fluid fast before surgery does not increase the risk of aspiration, regurgitation or related morbidity. Thus, the traditional view of ‘nil-by-mouth from midnight’ needs review as giving hydration is advantageous for the patient in preventing thirst and prolonged starvation.

Hausel et al. [66] conducted a randomised double-blinded control trial using the CHO drinks compared to placebo and a control group. The study was conducted in 252 patients undergoing elective laparoscopic cholecystectomy and major colorectal surgery. Patients with ASA 3 or greater and diabetics were excluded. Three groups

were compared: CHO (800ml the night prior to surgery + 400ml in the morning) versus placebo (identical taste and volume) versus fasting from midnight. Visual analogue scales were recorded at 4 time-points (baseline, prior to CHO drink, 40mins + 90mins after morning drink) for a number of outcome measures. The CHO drink increased well-being compared with placebo or fasting. It was also more effective than placebo in reducing hunger, thirst and anxiety, without increasing gastric volumes or acidity. The authors concluded that peri-operative discomfort could be reduced in a majority of patients with use of a CHO drink.

Macfie et al. [67] undertook an un-blinded randomised control trial in 100 patients undergoing elective major gastrointestinal surgery. The study comprised two phases, an outpatient pre-operative phase and inpatient post-operative phase. Patients were randomised to one of four groups: I-Pre & post-op supplements, II- pre-op supplements only, III- post-op supplements only or IV- no supplements. Endpoints included weight loss, mean serum albumin, mean mid-arm muscle circumference, mean hand grip strength, postoperative complication rate, mortality, hospital LOS and HAD score. There was less weight loss in Group I than II, III or IV (not significant; no p-value reported). A fall was observed in mean peri-operative serum albumin 5-8 g/L across four groups (not significant; no p-value reported). There was no observed difference between groups for the remaining outcomes measures (p-values not significant). The authors conclude that the routine use of perioperative CHO drinks in well-nourished patients confers no clinical or functional benefit.

3.2 Gap analysis

A gap analysis of ER elements was conducted at Birmingham Heartlands Hospital with additional visits to two further thoracic surgical units. These unit visits were designed to evaluate the implementation of ER in two other large thoracic surgical units. The visits included interviews with key members of local teams providing enhanced recovery. Results of these visits, gap analyses and interviews have been integrated into the construction of the enhanced recovery in thoracic surgery pathway at Heartlands Hospital.

1: Birmingham Heartlands Hospital

Although not a formalised ER programme, Heartlands hospital already has many elements in place for thoracic surgical patients. These include a well-established pre-habilitation programme, POAC, DOSA and robust early mobilisation practices with active daily physiotherapy input. The implementation of minimally invasive surgery is also increasing, although it is not yet well established.

2: University of South Manchester [UHSM]

On visiting UHSM discussions were had with the ER lead nurse across the hospital site. Having an ER leader was advantageous in facilitating the implementation ER, even if it did not yet include thoracic surgery. Pioneering ER came from non-thoracic surgical specialities, particularly colorectal and urology. ER elements at UHSM included a robust POAC and a nurse led post discharge follow up service. There

were however no patients admitted on DOS, no standardised analgesia protocol or routine use of digital drains to aid early mobilisation.

3: Bristol Royal Infirmary

This unit leads the UK in ER in thoracic surgery. All elements of ER are employed including an established POAC, the routine use of CHO loading supplements, DOSA, minimally invasive surgery, the use of digital drains to facilitate early post-operative mobilisation, a structured analgesic protocol and post discharge follow up. The only element not available to thoracic patients was pre-operative optimisation in the form of pre-habilitation,

The data from each unit analysis is summarised below in Table 7 [Full details of each unit visit - Appendix 6].

Table 7: Gap analysis - Summary data

Elements	BIRMINGHAM	MANCHESTER	BRISTOL
Getting the patient in best possible condition			
Primary Care Input			
Optimising Haemoglobin levels	No	No	POAC identifies problems
Managing pre-existing co morbidities e.g. Diabetes/Hypertension	No	No	POAC identifies problems
Pre-operative			
Health and Risk Assessment	POAC	Verbal by LCNS e.g. surgery info/VTE	OPC+POAC same day POAC has on hand anaesthetic consultants to review pts
Good Quality Patient Information	POAC- quantity (too much) and quality (too detailed)	Verbal by LCNS e.g. surgery info/VTE	Patient diary EDD given
Informed decision making	Discussion in OPC	Verbal discussion LCNS/OPC	Consent form (unsigned) given to patient to take home and read. Brings on DOSA
Managing patient's expectations of what will happen to them	???	Verbal discussion LCNS/OPC	See above
Optimised health/medical condition	???	Too late	
Therapy Advice	???		
Carbohydrate loaded drinks (high energy drinks)	No	No – no access	Yes. 2/7 pre-surgery High CHO on day of surgery 7/7 post surgery
Maximising patients hydration	? Patient information may lead to excess dehydration	No	Can drink water until 2hrs prior to surgery
Discharge Planning – expected date of discharge (EDD)	? Given	Yes	Given to patient in OPC
Admission			
Admit on day of surgery	Yes	No – night before	Yes - routine
Optimise fluid hydration	Unclear- ?dehydrated prior to surgery. No pre-op drinks or hydration	None	Water until 2hrs prior to surgery
Avoid routine use of sedative pre-medication	Yes	Yes	Yes
Carbohydrate loaded drinks (high energy drinks)	No	No	Yes

Getting the patient in best possible condition:

Even within the three units evaluated there is a wide variety in practice prior to surgery. The time between the patient's review in outpatient clinic and operation is short, often one to two weeks. All three units have robust pre-operative assessment clinic (POAC) to identify potential issues and prepare the patient for surgery. Key information is given in outpatient clinic (OPC) or POAC, so that the patients can be admitted on the day of their operation in Birmingham and Bristol. Only Bristol patients receive carbohydrate (CHO) drinks, one of the ER interventions identified from other surgical specialities programmes.

Elements	BIRMINGHAM	MANCHESTER	BRISTOL

The patient has the best possible management during surgery

Intra-operative			
Minimally invasive surgery if possible	Yes	Started	Yes. ¾ surgeons do VATS (53% lobes done by VATS, June 2012)
Individualised goal-directed fluid therapy	No	No – some trustwide use in other specialities	No
Avoid crystalloid overload	Yes	???	Yes
Epidural management	Yes	Yes – use of epid/PVC/regional blocks	Reducing number. PVC the norm.
Use of regional/spinal and local anaesthetic with sedation	Increasing use of PVC+PCA	Yes	PVC the norm
Hypothermia prevention	Yes	Yes	Yes

The patient has the best possible management during surgery:

There is a much greater degree of similarity between the three units in regard to their practices at the time of surgery. All three utilise minimally invasive surgery, use regional anaesthesia and prevent hypothermia.

Elements	BIRMINGHAM	MANCHESTER	BRISTOL

The patient experiences the best post-operative rehabilitation

Post Operative			
No routine use of wound drains	Yes	Yes	Yes
Chest drain management	Protocol- but ?compliance	100% rocket drains, usually only one	One ICD as standard
Active planned mobilisation within 24 hours	Yes	Planned, but patients in CTCCU so may not be mobilised	Yes
Early oral hydration	Yes	Yes	Yes
Early oral nutrition	Yes	Yes	Yes
IV therapy stopped early	Yes, but Recovery ask for IVI	Yes	None prescribed
Catheters removed early	Yes	Yes. Unusual to have catheter even with epidural	Yes
Regular oral analgesia e.g. paracetamol and NSAIDS	Yes, but ?protocol compliance	'Hit & miss'. No protocol	Yes, structured analgesic ladder
Avoidance of systemic opiate-based analgesia where possible	Variety in analgesic techniques: Morphine infusion, PVC+PCA	Yes	Yes. PCA used with PVC. Taken down as early as possible
Follow-up			
Discharge on planned day or when criteria met	?Yes	?	Yes. Consultant ward round daily
Therapy support (Physio, Dietician)	Yes	?	Yes
24 hour telephone follow-up call if appropriate	No	Have access. Phones 7-21 days post surgery	Yes. Called in first week post surgery

The patient experiences the best possible post-operative rehabilitation:

Post-operatively there are many similarities in practice between the three units. Early mobilisation, hydration and nutrition is standard whilst all units try and avoid

systematic opiate analgesia. After discharge two units, Manchester and Bristol contact their patients with a follow up telephone call.

3.3 National survey

3.3.1 Collation of results

Eighty three individuals responded from thirty-four out of forty (85%) units performing thoracic surgery in UK. Opinions from a range of healthcare professionals were recorded. The survey was conducted through a third party commercial partner and efforts to obtain the raw data were unsuccessful. Thus, exact details of total responder rate and response rate per healthcare professional from individual units in unknown.

Survey summary:

Areas of success identified included pulmonary rehabilitation before and after surgery, smoking cessation, nutritional optimisation, pre-operative assessment, optimising post-operative fluid management, early mobilisation and physiotherapy, digital drains and standardised pain protocol. However, admitting patients on the day of surgery, wider spread use of minimally invasive surgical techniques, minimising length of pre-operative starvation, provision of better quality patient information and post discharge care were areas with the poorest uptake within the UK. It is these areas where further promotion of ER practice could result in improved patient care.

3.3.1.1 *Pre-operative assessment clinic (POAC)*

With regards to provision of pre-assessment, 79% of responding units utilise a POAC (27/34 units). The majority of units (16/27 or 59%) using POAC facilities review >75% of their thoracic surgical patients. However, only 9/27 units (33%) with POAC facilities have an available anaesthetist to review the patient. The consensus belief is that POAC benefits patients by preparing them better (96% responses) resulting in fewer cancellations (77%).

3.3.1.2 *Day-of-surgery admission (DOSA)*

Of the 26 units reporting to have a POAC, only 31% (8 units) actually admit their patients on the day of surgery. The commonest reasons reported as barriers to DOSA are outlined in Table 8. Space was also left for individuals to comment specifically on their units own circumstances to further elucidate the barriers to DOSA.

Table 8: Reported barriers to day-of-surgery admission (DOSA).

Barriers to DOSA	Percentage
No surgical admission suite	83%
Anaesthetist preference not to admit day of surgery	61%
No DOSA in unit or hospital	44%

Surgeon preference not to admit day of surgery	44%
Logistic/geographical	17%

3.3.1.3 *Patient information*

The provision of thoracic specific patient information is high (94% units). It is predominantly in the form of written information (97% patients). However, only 71% units report that the information given is of good quality. Thus, the substantial remaining proportion of unit's belief is that their patient information needs improving.

3.3.1.4 *Starvation prior to surgery*

The time of starvation before operation, nil-by-mouth (NBM) period, was assessed in terms of fluids and solids. Seventy-four per cent of units report starving patients of fluids between 2 – 6 hours before surgery. Thus, over a quarter of patients do not receive any oral fluid intake for greater than 6 hours prior to surgery. When questioned regarding their beliefs, nearly nine out of ten units (87%) reported that the perceived NBM period for fluids should be less than 6 hours. With regards to oral solids, 10% report a NBM period less than 6 hours, while approximately three quarters of units (77%) report patients being NBM for food for between 6 and 12 hours before their operation. Ten per cent of units starve their patients for between 12 and 24 hours. This is in contrast to the reported beliefs, with 57% and 37% units believing the time should be 6 – 12 hours or less than six hours respectively.

3.3.1.5 *Minimally invasive surgery*

Ninety-two per cent of units report performing minimally invasive surgery for major lung resection. Table 9 shows the areas in which responders believed minimally invasive surgery had improved patient care.

Table 9. Areas of care in which units practicing VATS surgery had observed improvements.

Areas of improvement	**Percentage reported (24 units)**
Reduced LOS	96%
Improved patient satisfaction	92%
Improvements in pain score	83%
Reduced complications	67%
Reduced ITU admissions	46%
Reduced readmissions	42%

LOS, length of stay; ITU, intensive care unit

3.3.1.6 *Analgesia strategies*

Results of questions regarding analgesia strategies revealed a wide variety of practice in the UK. The most frequently reported methods undertaken were paravertebral catheters (PVC, 93% units), intravenous morphine infusion (90% units),

epidurals (73% units) and intra-thecal injections (10% units). Of the 28 units reporting the use of PVC, 16 (57%) placed them into >50% of patients.

Eighty-three per cent of units report having a standardised pain control guideline or protocol. This has been written specifically for thoracic surgery in 63% of cases. These analgesia guidelines include the regular use of laxatives in 75% units and regular non-steroidal anti-inflammatory drug (NSAID) prescription in 26% units.

3.3.1.7 *Physiotherapy provision*

Of those units responding, 79% have standardised post-operative physiotherapy guidelines. In approximately two thirds of cases (69%) it is reported to be written specifically for thoracic surgical patients. Specific questioning regarding aspects of these guidelines were asked. These include sitting the patient out on day 1 post-operatively (97% units) with a similar percentage (100%) of responders believing this to be best practice. Similarly, all responses (100%) believed mobilising the patient on day 1 was best practice, however only 86% units actually achieve this.

3.3.1.8 Post-discharge follow up

Ninety-seven per cent of units give patients thoracic surgery specific advice before discharge. This information is predominantly in the form of verbal advice (89% units) and written material (75% units). Further interventions included a patient diary (8% responding units) with patients receiving a DVD from 3% units.

Contact following discharge is achieved by 26% units, who telephone their patients within one week of discharge. In addition, two units (6%) report making home visits to patients after discharge. When responders were questioned regarding their beliefs, contact after discharge was seen to benefit patients in a number of ways. These include reduction in patient anxiety (95% responses), reduction in readmission rate (81%) and increased patient satisfaction (91%). Comments regarding post discharge follow up were also gathered.

3.3.1.9 Dissemination of results

The results of the survey were disseminated at the Enhanced Recovery session: Fulfilling the potential a better journey for patients a better deal for the NHS at Society for Cardiothoracic Surgery in Great Britain & Ireland, Annual Meeting 2013 in Brighton [Appendix 2].

3.4 Enhanced recovery pathway development

Local guidelines have been drawn up, discussed, reviewed and amended by key stake holders. Key elements already established at Heartlands Hospital were augmented by evidence from the literature review and gap analyses (Figure 8).

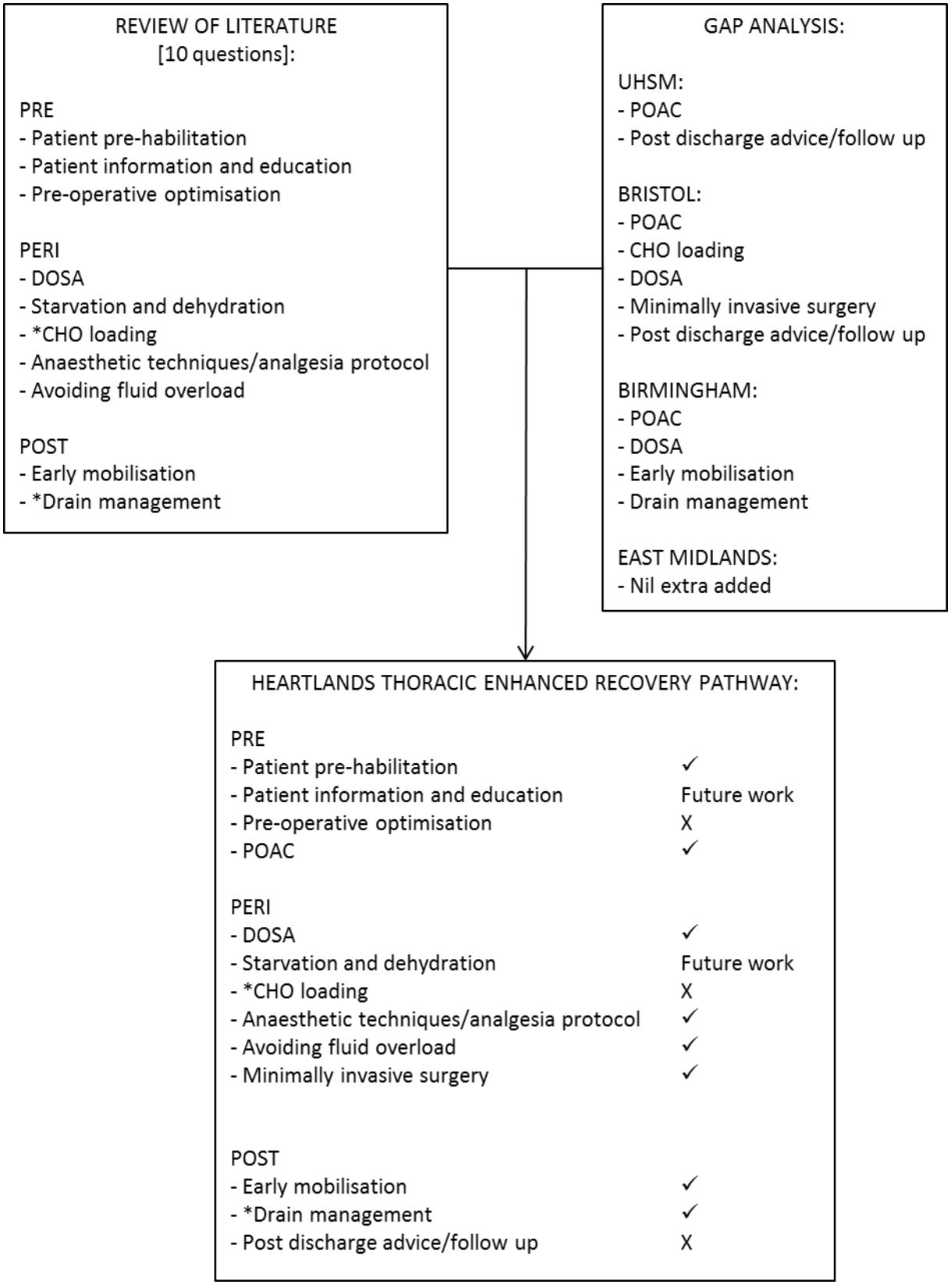


Figure 8: ER pathway development

Review of Figure 8 reveals that a number of key ER elements are already in place at Heartlands Hospital (✓), whilst others are not (X). Construction of the ER manual highlighted three further areas that needed addressing at a local level (Future work on Figure 4), namely improved patient information a process to reduce pre-operative dehydration and a standardised analgesia protocol.

This has led to the construction of our ERAS manual giving detail of each step and element within the thoracic ERAS programme at Birmingham Heartlands Hospital (Figure 9).

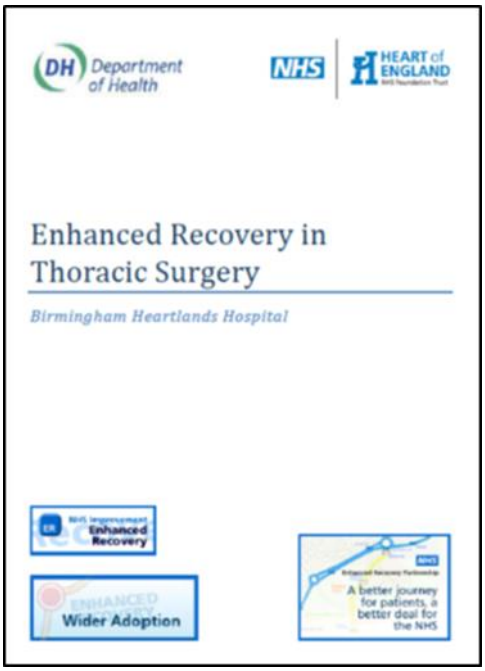


Figure 9: Enhanced recovery in thoracic surgery- Birmingham Heartlands Hospital manual

The completed manual has been distributed to other thoracic surgical units interested in starting an ER programme. The manual is included in Appendix 2.

3.5 Testing the pathway

Since the launch of the ERAS programme at Heartlands Hospital in February 2013, the initial effect on number of deaths, LOS and PPC rate have been analysed. Data on 275 patients undergoing VATS lobectomy and 272 patients having a lobectomy via thoracotomy has been collected. This data is displayed in 1-year time intervals, starting 1 year before the introduction of the ERAS programme.

Table 10: Patient demographics

		Total (n)	Age (yrs) [mean +/- SD]	Male [%]	BMI (kg/m2) [mean +/- SD]	FEV1 (L) [mean +/- SD]
VATS	Feb 12 - Jan 13	46	70.2 +/- 8.0	56.5	26.2 +/- 4.2	85.6 +/- 20.6
	*Feb 13 - Jan 14	59	66.3 +/- 10.4	45.8	26.6 +/- 5.0	87.8 +/- 19.8
	Feb 14 - Jan 15	78	67.5 +/- 11.4	53.8	26.4 +/- 5.4	86.2 +/- 17.6
	Feb 15 - Jan 16	92	67.7 +/- 8.5	39.1	26.8 +/- 4.7	89.2 +/- 21.4
Thoracotomy	Feb 12 - Jan 13	75	67.5 +/- 9.4	50.7	26.8 +/- 5.2	87.4 +/- 21.2
	*Feb 13 - Jan 14	78	66.8 +/- 10.0	52.6	27.0 +/- 5.8	89.2 +/- 20.5
	Feb 14 - Jan 15	60	68.4 +/- 9.6	46.7	26.3 +/- 4.8	87.5 +/- 20.4
	Feb 15 - Jan 16	59	67.7 +/- 11.9	61.0	27.2 +/- 4.6	86.7 +/- 21.0

*:introduction of ERAS in February 2013

Table 11: Patient outcomes

		Total (n)	Deaths (n)	LOS (days) [median + IQR]	PPC rate (n/%)
VATS	Feb 12 - Jan 13	46	0	4 (3 - 6)	3 (6.5%)
	*Feb 13 - Jan 14	59	1	4 (3 - 6)	5 (8.5%)
	Feb 14 - Jan 15	78	1	4 (3 - 5)	6 (7.7%)
	Feb 15 - Jan 16	92	1	4 (3 - 5)	5 (5.4%)
Thoracotomy	Feb 12 - Jan 13	75	2	6 (5 - 9)	20 (26.7%)
	*Feb 13 - Jan 14	78	0	6 (4 - 9)	10 (12.8%)
	Feb 14 - Jan 15	60	2	6 (4 - 10)	12 (20.0%)
	Feb 15 - Jan 16	59	2	6 (5 - 9)	7 (11.8%)

*:introduction of ERAS in February 2013

In the study period there is an almost equal number of patients undergoing VATS lobectomy as those having a thoracotomy. However, there is an increasing number of lobectomies for primary lung cancer being performed via minimally invasive approach [VATS]. Patient demographics are similar allowing comparison between the two surgical approaches. There are however more women undergoing VATS lobectomy as opposed to a thoracotomy in the latter study group [Feb 15 – Jan 16]. The outcomes show that LOS is stable and has not deteriorated since the introduction of ERAS. The number of patient deaths has also remained very low. There is a trend towards a reduction in PPC rates for patients undergoing a thoracotomy for primary lung cancer, which is not seen in the VATS group.

4 DISCUSSION & CONCLUSIONS

Enhanced recovery in thoracic surgery is in its relative infancy. ER is not routinely practiced throughout the UK thoracic surgical community, but rather is concentrated in a handful of units. Even within the localised geographical region sampled, the unit visits and gap analyses highlighted variations in ER practice. Due to the large proportion of the workload being elective, non-emergency work, thoracic surgery lends itself to the application of ER principles and practice. ER can be applied to the entire patient journey, even within the relatively confined time pressure for cancer patients to undergo surgery.

4.1 Review of the literature

The review encompassed two elements of ER, management of intercostal chest drains after surgery and the use CHO loading supplements given prior to operative procedures.

4.1.1 Chest drain management

The way in which chest drains are managed after thoracic surgery has been extensively researched. Despite numerous papers being published on various aspects of chest drain management, there is still no consensus between surgical units or individual surgeons. The literature is summarised below:

- Digital drains superior to traditional underwater seal [48-50]
- Drainage- ICDs can be removed once fluid quantity is less than 200ml/day [48,49,52,58], 250ml/day [50, 53], 400ml/24hrs [51]
- Drain protocol advantageous [52]
- Milking ICDs not advised [53]
- Lobectomies- only one ICD favoured as compared with two [54, 55]
- VATs lung biopsy- no ICD drain favoured when no intraoperative air leak detected [56,57]
- Routine application of suction- not necessary post lung resection [58, 59]

Digital drains, connected to the patient's chest tube, are superior to the traditional underwater seal system. These permit earlier mobilisation, accurate display of air leak for the lung and have a number of built-in safety alarms. There remains however a wide variety in practice, within the literature, in terms of drain removal with regards to fluid drainage. Chest drains can be removed once fluid quantity ranges from less than 200ml/day to 400ml/day. This has led to the construction of a drain removal protocol in our unit to prevent drains being left in unnecessarily, which can carry significant patient morbidity. It also speeds up decision making for junior medical staff when it comes to making the decision to remove a drain.

4.1.2 Carbohydrate loading

Although no papers were found to address the question of carbohydrate loading in thoracic surgical patients, there are a number of studies from other surgical specialities. In particular, there are several studies in gastrointestinal surgery. Five prospective randomised control trials have found several key advantages that could potentially benefit thoracic surgical patients. Improved gastrointestinal function, reduced loss of muscle mass and reduced LOS has been demonstrated in non-thoracic surgical patients. There are also no reported disadvantages, and although supplying CHO drinks has a financial implication, overall they may also be cost-effective providing savings in other areas.

4.2 Current processes in thoracic surgery

To capture the current practices in thoracic surgery an attempt was made to analyse three units with a wide experience of delivering ER. Interviews conducted at these units and analysis of the ER elements being employed, successful or otherwise, fed into information for the review. Combined with a national survey, the gap analyses fed forward enabling the construction of an ER programme at Heartlands Hospital.

The objective of the ER survey was to evaluate the current state of ER practice in thoracic surgery within the UK. It captured, as accurately as possible, the practices and beliefs of a significant proportion of the total thoracic units within the UK. Eighty-five percent of units undertaking thoracic surgery responded to the survey.

Responders included consultant surgeons, trainees, nurses and physiotherapists giving a broad perspective on each unit's ER practice. The majority of units had pre-operative assessment facilities, permitting day of surgery admission, but only a third had immediate anaesthetic input available. In the units with POAC only a third admitted patients on DOS, with barriers reported including surgeon or anaesthetist preference not to admit DOS, no DOSA unit and patient factors of geography or logistics. The ability to admit on DOS is a key element of ER and thus these deficiencies need addressing. Additionally, the starvation period prior to surgery merits improvement, as a quarter of patients are starved excessively of fluids and food. Performance of minimally invasive surgery for major lung resection was reported in 90% units surveyed, in stark contrast to national audit data showing only 15% major lung resections being undertaken by VATS. Some of this disparity may be due to the audit data being three years old and thus failing to reflect a recent increase in the number of surgeons performing major resections by VATS. However, this difference remains large and can't just be attributable to old data. With regards to analgesic strategies, the national picture is mixed, with most units reporting using a variety of techniques including epidurals, para-vertebral catheters and intravenous morphine. Encouragingly, the majority of units have a standardised post-operative physiotherapy protocol designed to reduce complications including sputum retention and lung collapse, chest infections and venous thromboembolism. Provision of patient information following discharge was very high, usually in written form, but one third of units believed the quality needed improving.

This project has delivered the first national survey of ER practice in thoracic surgery. The results not only highlight the good practices of ER across the country but also

reveal areas for improvement. The key areas to address include reducing the period of pre-operative starvation, facilitating DOSA, increasing the number of major resections completed by VATS and promoting post-discharge contact with patients to reduce readmission rates and increase patient satisfaction.

4.3 Enhanced Recovery in thoracic surgery

Building on the processes and elements already in place, the ER manual constructed from the literature review, gap analysis and national survey led to the formulation of an ER pathway for thoracic surgical patients at Birmingham Heartlands Hospital. The manual also facilitates other thoracic units in constructing an ER pathway.

The resultant pathway was formally introduced in February 2013. Prior to the start date key stakeholders had been informed (e.g. ward staff given presentation) and the process advertised in the thoracic surgical ward. Having an established start enabled data to be collected and thus the effect of the pathway evaluated.

Early indicators using the quantitative data collected suggest that there has been an increase in the utilisation of minimally invasive operative techniques and a reduction in post-operative complications, without an increase in patient mortality. These benefits reflect the published literature with regards to reduced LOS observed in several surgical specialities including colorectal [4-12,17-20], non-colorectal [27-30, 34] and thoracic [39-42]. Similarly benefits of reduced post-operative complication rates, particularly pulmonary complications, observed in our data reflect the published literature [29,39,40,42]. These observed improvements we need to be consolidated and at this time no long-term data is available. The success, or

otherwise, of this ER programme will depend on the sustainability of these advantages. Additionally, improvements in patient reported outcome measures (PROMs) [12] and readmission rates [13-15,30], whilst reducing costs [4,21,22] have been reported. Data for these outcome measures will need to be collected in the future to evaluate the potential benefits of ER for thoracic surgical patients.

4.4 Limitations

Enhanced recovery in thoracic surgery

The bulk of work undertaken in ER comes from non-thoracic surgical specialities. Initial experience in thoracic surgery has often involved borrowing and modifying these existing pathways prior to implementation. Some of the elements have needed to be changed or tailored towards thoracic surgical patients, but otherwise the principles remain the same. It is thus hoped that the benefits already established in other specialities can be applied to thoracic surgery. Logically, if it improves the care of non-thoracic surgical patients it must also benefit patients undergoing lung surgery. To this extent the first paper outlining an ER programme in thoracic surgery was published in 2016 [40].

Overall, ER pathways can then be compared to the previous standard of care and benefits, or otherwise, can be measured. The difficulty comes when trying to assess the effect of individual ER components within an established programme. It is hardly ethical to start removing individual elements from an ER programme, to measure the effect of one component, if the entire pathway has been shown to convey an advantage. Thus, it is very difficult to measure the effect of single elements within an

established pathway, to identify which convey the biggest advantage. One approach would be to introduce every element one at a time and evaluate the effect. There are a number of difficulties with this approach, the most problematic being that each change is likely to only bring about a small improvement, too small to accurately measure. It is the sum of all these small improvements that gives patients in ER programmes maximal benefit. Conversely, the second approach would be to introduce ER wholesale and compare it to the previous standard of care, accepting that it is difficult to tease out the effect of individual elements. This has the advantage of being a simpler approach in terms of measuring outcomes, but again has difficulties. Adopting an entirely new way of working, and thinking about how patients are managed, can often be met with resistance. Going against an established dogma of practice can make changes difficult. Introducing smaller changes may be easier to accept.

Study limitations

There are a number of limitations to this study. This project has been constructed, analysed and completed by a solo PGR. It thus leaves the study open to a number of weaknesses. The literature review was conducted independently and is thus open to selection bias. Similarly the gap analysis was conducted by the PGR and may have been improved with training and experience of qualitative interview analysis. The survey was conducted by a third party and although the results were available, the raw data, including key indicators of quality (such as percentage response rate and response rate per healthcare professional type) was not. The ER pathway

construction was entirely healthcare professional led. There was a lack of patient involvement in pathway design and outcomes. The acceptability of ER was not investigated outside the sphere of healthcare professionals, nor was quality of life or quality of improvement measures taken into consideration. The pathway testing focused on more easily obtained quantitative outcome measures, whilst qualitative data was not obtained. The study could thus be enhanced by addressing these issues.

Summary

Despite the limitations with this study, I am convinced that adopting ER into thoracic surgery will only result in benefits for this patient group. Improving patient satisfaction alongside reduced complication rates, length of inpatient stay and readmission rates can only be advantageous. Building on the work from other surgical specialities, I believe the wider adoption of ER for thoracic surgical patients will result in improved patient care.

5 FUTURE WORK

There are several areas in which future work should focus. Locally, the implementation of dehydration prevention strategies and analgesia prescription can be audited and the effects evaluated. Then the decision can be made as to whether these two interventions should be retained as part of the ER programme. It is difficult

to tease out effect of individual elements as most pathways are imported wholesale. But within established pathways, new elements are more easily evaluated. For example, the production of a new thoracic surgery specific patient information booklet may be advantageous once introduced into an established ER programme. The effect on clinically relevant outcomes, as well as patient reported outcome measures, can be evaluated after its introduction.

Future outcome measures

Further work should encompass pain scores, time to first mobilisation, analysis of ER pathway completion rates, EP bundle usage and the implementation of preventing dehydration strategies. The alteration to starvation instructions prior to surgery has yet to be evaluated.

It is hypothesised that the patient experience will be improved by reducing the unpleasant sensation of thirst prior to surgery, whilst reducing the amount of peri-operative intravenous fluid needing to be administered. The impact of ‘My Lung Surgery Handbook’ (Appendix 4) has also yet to be analysed, as it is hypothesised that improving patient education will result in better clinical as well as patient reported outcome measures.

Qualitative outcome measures including patient acceptance of ER pathway, quality of life and quality of information should also be investigated.

The Future

Nationally, interest in ER is gathering. Speaking to colleagues in other units, highlighting the benefits to others and showcasing on a national stage will push ER to the fore. However, changing the perception of others who may not believe in the benefits of ER and challenging surgical dogma will ultimately be the biggest test. This can be achieved, but will require evidence. The advantages of established thoracic surgery specific ER practice will have to be demonstrated in the published literature. It will also be advantageous to identify the key elements bringing the biggest gains. Targeting future endeavours to these key areas will enable maximal improvements to patient care and resulting benefits to the NHS.

6 REFERENCES

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth 1997; 78: 606-17

2. Delivering enhanced recovery: Helping patients get better sooner (Enhanced Recovery Partnership Programme, Department of Health, United Kingdom) (http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_119382.pdf)

3. Wind J, Polle SW, Fung Kon Jin PHP, Dejong CHC, von Meyenfeldt MF, Ubbink DT et al. Systematic review of enhanced recovery programmes in colonic surgery. Br J Surg 2006; 93: 800-9

4. Adamina M, Kehlet H, Tomlinson GA, Senagore AJ, Delaney CP. Enhanced recovery pathways optimise health outcomes and resource utilisation: a meta-analysis of randomised controlled trials in colorectal surgery. Surgery 2011; 149: 830-40.

5. Spanjersberg WR, Reurings J, Keus F, van Laarhoven CJHM. Fast track surgery versus conventional recovery strategies for colorectal surgery (review). Cochrane Database of Systematic Reviews 2011, Issue 2. Art. No.: CD007635

6. Basse L, Hjort JD, Billesbolle P, Werner M, Kehlet H. A clinical pathway to accelerate recovery after colonic resection. Ann Surg 2000; 232: 51-7

7. Muller S, Zalunardo MP, Hubner M, Clavien PA, Demartines N. A fast-track program reduces complications and length of stay after open colonic surgery. Gastroenterology 2009; 136: 842-7

8. Raue W, Haase O, Junghans T, Scharfenberg M, Muller JM, Schwenk W. 'Fast-track' multimodal rehabilitation program improves outcome after laparoscopic sigmoidectomy: a controlled prospective evaluation. Surg Endosc 2004; 18: 1463-8

9. Basse L, Thorbol JE, Lossl K, Kehlet H. Colonic surgery with accelerated rehabilitation or conventional care. Dis Colon Rectum 2004; 47: 271-7

10. Hammond JS, Humphries S, Simson N, Scrimshaw H, Catton J, Gornall C, Maxwell-Armstrong C. Adherence to enhanced recovery after surgery protocols across a high-volume gastrointestinal surgical service. Dig Surg 2014; 31: 117-122

11. Tang J, Humes DJ, Gemmil, E, Welch NT, Parsons SL, Catton JA. Reduction in length of stay for patients undergoing oesophageal and gastric resections with implementation of enhanced recovery packages. Ann R Coll Surg Engl 2013; 95: 323-8

12. Anderson AD, McNaught CE, MacFie J, Tring I, Barker P, Mitchell CJ. Randomised clinical trial of multimodal optimisation and standard perioperative surgical care. Br J Surg 2003; 90: 1497-1504

13. Goodney PP, Stukel TA, Lucas FL, Finlayson EV, Birkmeyer JD. Hospital volume, length of stay and readmission rates in high-risk surgery. Ann Surg 2003; 238: 161-7

14. Anderson J, Hjort-Jakobsen D, Christiansen PS, Kehlet H. Readmission rates after a planned hospital stay of 2 versus 3 days in fast-track colonic surgery. Br J Surg 2007; 94: 890-3

15. Delaney CP. Outcome of discharge with 24 to 72 hours after laparoscopic colorectal surgery. Dis Colon Rectum 2008; 51: 181-5

16. Varadhan KK, Neal KR, Dejong CH, Fearon KC, Ljungqvist O, Lobo DN. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomised controlled trials. Clin Nutr 2010; 29: 434-40

17. Khoo CK, Vickery CJ, Forsyth N, Eyre-Brook IA. A prospective randomised controlled trial of multimodal perioperative management protocol in patients undergoing elective colorectal resection for cancer. Ann Surg 2007; 245: 867-72

18. Serclova Z, Dytrych P, Marvan J, Nova K, Hankeova Z, Ryska O, Slegrova Z, Buresova L, Travnlkova L, Antos F. Fast-track in open intestinal surgery: prospective randomized trial (Clinical Trials Gov Identifier no. NCT00123456). Clin Nutr 2009; 28: 618-24

19. Delaney CP, Zutshi M, Senagore AJ, Remzi FH, Hammel J, Fazio VW. Prospective, randomized, controlled trial between a pathway of controlled

rehabilitation with early ambulation and diet and traditional postoperative care after laparotomy and intestinal resection. Dis Colon Rectum 2003; 46:851-9.

20. Gatt M, Anderson AD, Reddy BS, Hayward-Sampson P, Tring IC, MacFie J. Randomized clinical trial of multimodal optimization of surgical care in patients undergoing major colonic resection. Br J Surg 2005; 92: 1354-62.

21. King PM, Blazeby JM, Ewings P, Longman RJ, Kipling RM, Franks PJ, Sheffield JP, Evans LB, Soulsby M, Bulley SH, Kennedy RH. The influence of an enhanced recovery programme on clinical outcomes, costs and quality of life after surgery for colorectal cancer. Colorectal Dis 2006; 8: 506-13

22. Lemanu DP, Singh PP, Stowers MD, Hill AG. A systematic review to assess cost effectiveness of enhanced recovery after surgery programmes in colorectal surgery. Colorectal Dis 2014; 16: 338-46

23. Kehlet H, Dahl JB. Anaesthesia, surgery, and the challenges in postoperative recovery. Lancet 2003; 362: 1921-8

24. Fearon KC, Ljungqvist O, Von Meyenfeldt MF, Revhaug A, Dejong CH, Lassen K, Nygren J, Hausel J, Soop M, Anderson J, Kehlet H. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. Clin Nutr 2005; 24:466-77

25. Lassen K, Soop M, Nygren J, Cox PB, Hendry PO, Spies C, von Meyenfeldt MF, Fearon KC, Revhaug A, Norderval S, Ljungqvist O, Lobo DN, Dejong CH. Consensus review of optimal perioperative care in colorectal surgery:

Enhanced Recovery After Surgery (ERAS) Group recommendations. Arch Surg 2009; 144: 961-9

26. Gustafsson UO, Scott MJ, Schwenk W, Demartines N, Roulin D, Francis N, McNaught CE, MacFie J, Liberman AS, Soop M, Hill A, Kennedy RH, Lobo DN, Fearon K, Ljungqvist O. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Clin Nutr 2012; 31: 783-800

27. Arumainayagam N, McGrath J, Jefferson KP, Gillat DA. Introduction of an enhanced recovery protocol for radical cystectomy. BJU Int 2008; 101: 698-701

28. van Dam RM, Hendry PO, Coolsen MM, Bemelmans MH, Lassen K, Revhaug A, Fearon KC, Garden OJ, Dejong CH. Initial experience with a multimodal enhanced recovery programme in patients undergoing liver resection. Br J Surg 2008; 95: 969-75

29. Munitiz V, Martinez-de-Haro LF, Ortiz A, Ruiz-de-Angelo D, Pastor P, Parrila P. Effectiveness of a written clinical pathway for enhanced recovery after transthoracic (Ivor Lewis) oesophagectomy. Br J Surg 2010; 97: 714-18

30. Grantcharov TP, Kehlet H. Laparoscopic gastric surgery in an enhanced recovery programme. Br J Surg 2010; 97: 1547-51

31. Findlay JM, Tustian E, Millo J, Klucniks A, Sgromo B, Marshall REK, Gilles RS, Middleton MR, Maynard ND. The effect of formalizing enhanced recovery after oesophagectomy with a protocol. Dis Esophagus 2015; 28: 567-73

32. Findlay JM, Gilles RS, Millo J, Sgromo B, Marshall REK, Maynard ND. Enhanced recovery for esophagectomy: a systematic review and evidence-based guidelines. Ann Surg 2014; 259: 413-31

33. Underwood TJ, Noble F, Madhusudan N, Sharland D, Fraser R, Owsley J, Grant M, Kelly JJ, Byrne JP, on behalf of the South Coast Cancer Collaboration-Oesophago-Gastric (SC-OG). The development, application and analysis of an enhanced recovery programme for major oesophagogastric resection. J Gastrointest Surg 2017; 21: 614-21

34. Sjetne IS, Krogstad U, Ødegård S, Engh ME. Improving quality by introducing enhanced recovery after surgery in a gynaecological department: consequences for ward nursing practice. Qual Saf Health Care 2009; 18: 236-40

35. Rasburn N, Batchelor T, Casali G, Evans C. The first UK experience of an enhanced recovery program in thoracic surgery. Enhanced Recovery after Surgery Society UK, 2011. www.erasuk.net

36. Mühling B, Orend KH, Sunder-Plassmann L. Fast track in thoracic surgery. Chirurg 2009; 80: 706-10

37. Jones NL, Edmonds L, Ghosh S, Klein AA. A review of enhanced recovery for thoracic anaesthesia and surgery. Anaesthesia 2013; 68: 179-89

38. Fiore JF, Bejjani J, Conrad K, Niculiseanu P, Landry T, Lee L, Ferri LE, Feldman LS. Systematic review of the influence of enhanced recovery pathways in elective lung resection. J Thorac Cardiovasc Surg 2016; 151: 708-15

39. Paci P, Madani A, Lee L, Mata J, Mulder DS, Spicer J, Ferri LE, Feldman LS. Economic impact of an enhanced recovery pathway for lung resection. Ann Thorac Surg 2017; 104: 950-7

40. Scarci M, Solli P, Bedetti B. Enhanced recovery pathway for thoracic surgery in the UK. J Thorac Dis 2016; 8(Suppl 1): S78-S83

41. Madani A, Fiore JF, Wang Y, Bejjini J, Sivakumaran L, Mata J, Watson D, Carli F, Mulder DS, Sirosis C, Ferri LE, Feldman LS. An enhanced recovery pathway reduces duration of stay and complications after open pulmonary lobectomy. Surgery 2015; 158: 899-910

42. Li S, Zhou K, Che G, Yang M, Su J, Shen C, Yu P. Enhanced recovery programs in lung cancer surgery: systematic review and meta-analysis of randomised controlled trials. Cancer Manag Res 2017; 9: 657-70

43. Quality improvement made simple: what everyone should know about healthcare quality improvement. London: Health Foundation 2013.

44. NHS Improvement: First steps towards quality improvement- a simple guide to improving services. http://webarchive.nationalarchives.gov.uk/20160805121829/http://www.nhsiq.nhs.uk/media/2591385/siguide.pdf

45. Page R, McShane J, Kinsman R. The Society for Cardiothoracic Surgery in Great Britain and Ireland: Second National Thoracic Surgery Activity & Outcomes Report. Published by Dendrite Clinical Systems Ltd: Henley-on-Thames; 2011. ISBN 978-0-9568154-1-5

46. Reeve JC, Nicol K, Stiller K, McPherson KM, Denehy L. Does physiotherapy reduce the incidence of postoperative complications in patients following pulmonary resection via thoracotomy? A protocol for a randomised controlled trial. J Cardiothorac Surg 2008; 3: 48 doi: 10.1186/1749-8090-3-48

47. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011.

48. Brunelli A, Slati M, Refai M, Di Nunzio L, Xiume F, Sabbatini A. Evaluation of a new chest tube removal protocol using digital air leak monitoring after lobectomy: a prospective randomised trial. Eur J Cardiothorac Surg 2010; 37: 56-60

49. Filosso PL, Ruffini E, Solidoro P, Molinatti, Bruna MC, Oliaro A. Digital air leak monitoring after lobectomy for primary lung cancer in patients with moderate COPD: can a fast-tracking algorithm reduce postoperative costs and complications. J Cardiovasc Surg 2010; 51: 429-33

50. Varela G, Jimenez MF, Novoa NM, Aranda JL. Postoperative chest tube management: measuring air leak using an electronic device decreases variability in the clinical practice. Eur J Cardiothorac Surg 2009; 35: 28-31

51. Hessami MA, Najafi F, Hatami S. Volume threshold for chest tube removal: a randomised controlled trial. J Inj Violence Res 2009; 1: 33-6

52. Martin-Ucar AE, Passera E, Vaughan R, Rocco G. Implementation of a user-friendly protocol for interpretation of air-leaks and management of intercostal chest drains after thoracic surgery. Inter Cardiovasc Thorac Surg 2003; 2: 251-55

53. Dango S, Sienel W, Passlick B, Stremmel C. Impact of chest tube clearance on prospective morbidity after thoracotomy: results of a prospective, randomised trial. Eur J Cardiothorac 2010; 37: 51-5

54. Okur E, Bayungar V, Tezel C, Sevilgen G, Ergene G, Gokce M, Halezeroglu S. Comparison of the single or double chest tube applications after pulmonary lobectomies. Eur J Cardiothorac Surg 2009; 35: 32-6

55. Dawson AG, Hosmane S. Should you place one or two chest drains in patients undergoing lobectomy? Inter CardioVasc Thorac Surg 2010; 11: 178-81

56. Luckraz H, Rammohan KS, Phillips M, Abel R, Karthikeyan S, Kulatilake NEP, O'Keefe PA. Is an intercostal chest drain necessary after video-assisted thorascopic (VATS) lung biopsy? Ann Thorac Surg 2007; 84: 237-9

57. Koc T, Routledge T, Chambers A, Scari M. Do patients undergoing lung biopsy need a postoperative chest drain at all? Inter CardioVasc Thorac Surg 2010; 10: 1022-5

58. Sanni A, Critchley A, Dunning J. Should chest drains be put on suction or not following pulmonary lobectomy? Inter CardioVasc Thorac Surg 2006; 5: 275-8

59. Prokakis C, Koletsis EN, Apostolakis E, Panagopoulos N, Kouki HS, Sakellaropoulos GC, Filos K, Dougenis DV. Routine suction of intercostal drains is not necessary after lobectomy: a prospective randomised trial. World J Surg 2008; 32: 2336-42

60. Hendry PO, van Dam RM, Bukkems SFFW, McKeown DW, Parks RW, Preston T, Dejong CHC, OJ Garden, Fearon KCH on behalf of the Enhanced Recovery After Surgery (ERAS) Group. Randomised clinical trial of laxatives and oral nutritional supplements with an enhanced recovery after surgery protocol following liver resection. Br J Surg 2010; 97: 1198-1206

61. Mathur S, Plank LD, McCall JL, Shapkov P, McIlroy K, Gillanders LK, Merrie AEH, Torrie JJ, Pugh F, Koea JB, Bissett IP, Parry BR. Randomised controlled trial of preoperative oral carbohydrate treatment in major abdominal surgery. Br J Surg 2010; 97: 485-94

62. Noblett SE, Watson DS, Huong H, Davison B, Hainsworth PJ, Horgan AF. Pre-operative oral carbohydrate loading in colorectal surgery: a randomised controlled trial. Colorectal Dis 2006; 8: 563-9

63. Yuill KA, Richardson RA, Davidson HIM, Garden OJ, Parks RW. The administration of an oral carbohydrate-containing fluid prior to major elective upper-gastrointestinal surgery preserves skeletal muscle mass postoperatively- a randomised clinical trial. Clin Nutr 2005; 24: 32-7

64. Smedley F, Bowling T, James M, Stokes E, Goodger C, O'Connor O, Oldale C, Jones P, Silk D. Randomised clinical trial of the effects of preoperative and postoperative oral nutritional supplements on clinical course and cost of care. Br J Surg 2004; 91: 983-90

65. Brady MC, Kinn S, Stuart P, Ness V. Preoperative fasting for adults to prevent perioperative complications. Cochrane Database of Systematic Reviews 2003, Issue 4. Art. No.: CD004423

66. Hausel J, Nygren J, Lagerkranser M, Hellstrom PM, Hammarqvist F, Almstrom C, Lindh A, Thorell A, Ljungqvist O. A carbohydrate-rich drink reduces preoperative discomfort in elective surgery patients. Anesth Analg 2001; 93: 1344-50

67. Macfie J, Woodcock NP, Palmer MD, Walker A, Townsend S, Mitchell CJ. Oral dietary supplements in pre- and post-operative surgical patients: a prospective and randomised clinical trial. Nutrition 2000; 16: 723-8

7 APPENDIX

Appendix 1- Enhanced Recovery: Fulfilling the potential, a better journey for patients and a better deal for the NHS [Society for Cardiothoracic Surgery in Great Britain & Ireland, Annual Meeting 2013]

Appendix 2- Enhanced recovery in thoracic surgery- Birmingham Heartlands Hospital manual

Appendix 3- Electronic prescription for thoracic surgical patients- 6 new bundles to replace existing 2 bundles

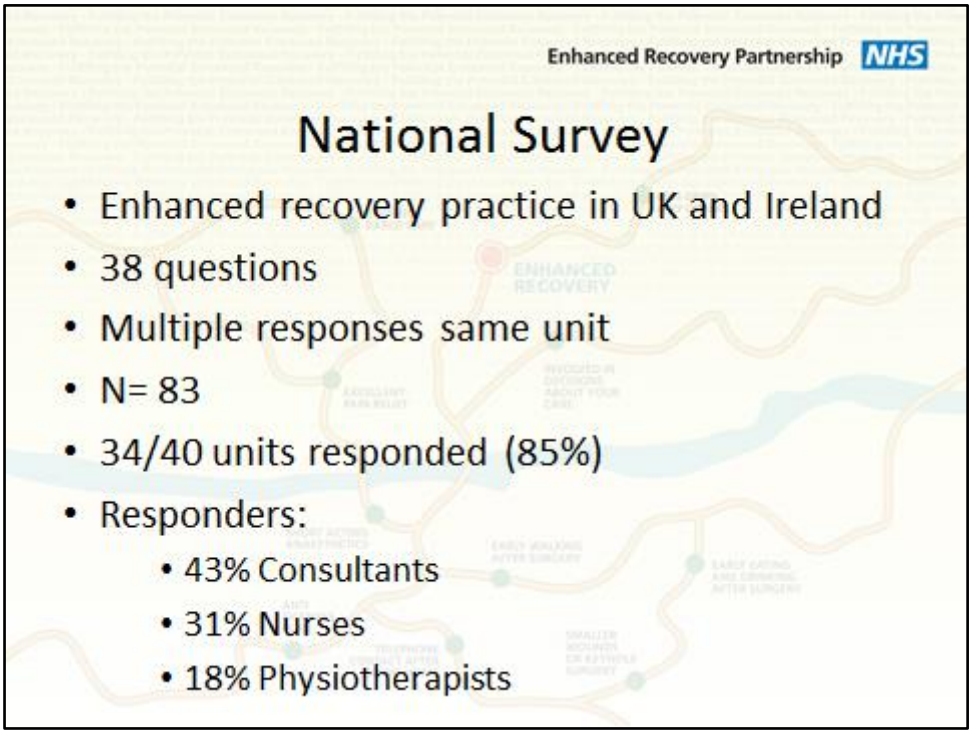
Appendix 4- My Lung Surgery Handbook

Appendix 5- Literature search strategies for chest drain management and carbohydrate loading

Appendix 6- Gap analyses

APPENDIX 1: ENHANCED RECOVERY- FULFILLING THE POTENTIAL A BETTER JOURNEY FOR PATIENTS AND A BETTER DEAL FOR THE NHS
[Society for Cardiothoracic Surgery in Great Britain & Ireland, Annual Meeting 2013]

Presenter: Mr R Wotton. Authors: Mr B Naidu, Mr R Wotton



Enhanced Recovery Partnership NHS

Pre-Operative Assessment Clinic

- Elective thoracic (lung) surgery patients
- 26/34 units (76%) have POAC
- 16/26 units >75% patients reviewed in POAC
- Only 9/26 units – anaesthetic input available in POAC
- Benefits: Patients better prepared (96%)
  Fewer cancellations (77%)

Enhanced Recovery Partnership NHS

Patient information

- 94% units give thoracic surgery specific information
- 97% patients receiving written information
- 67% units rated their information as good quality
- One third report their information needs improving

Enhanced Recovery Partnership NHS

Day of surgery admission

- Units with POAC *only* 31% admit on DOS (8/26 units)
- Remaining 18 units site following as barriers:

Barriers to DOSA	Percentage
No SAS	83%
Anaesthetist preference not to admit day of surgery	61%
No DOSA in unit or hospital	44%
Surgeon preference not to admit day of surgery	44%
Logistic/geographical	17%

Enhanced Recovery Partnership NHS

Day of surgery admission- comments

"Only small cases on day as have problems ring fencing beds!!"

"Depends where the patient is on the theatre list"

"Based more on comorbidity than surgery"

"Pre-op INR monitoring, feeding for oesophagetomy or pre-op physio intervention eg resp or rehab"

"Patients who live >1 hr away"

"Patient first on the list comes in the day before. Uncontrolled diabetes / transport issues"

"Anaesthetists like them in the day before!"

"Occasional medi's and bronch's Depends on geographical factors and co-morbidities"

Enhanced Recovery Partnership NHS

Day of surgery admission- barriers

"Beds are filled with patients if the beds are free, so admitting day before surgery is beneficial"

"Often difficulty with beds"

"Patient benefits from hospital stay preop. DOSA unproven benefit"

"DOSA under development. Logistical Issues"

"Resistance from anaesthetists and admission unit over capacity already"

"No "suitable" surgical admission suite (wrong building, remote from thoracic theatre"

"Geographical"

Enhanced Recovery Partnership NHS

NBM prior to surgery

- NBM for fluids:
  - 76% units starve fluids for 2-6hrs
- NBM for nutrition:
  - 77% units starve for food for 6-12hrs

Enhanced Recovery Partnership NHS

Minimally invasive surgery

- 90% units surveyed do VATS surgery
- So, how is it that only ~15% lobectomies conducted via VATS?

Areas of improvement	Percentage reported (24 units)
Reduced LOS	96%
Improved patient satisfaction	92%
Improvements in pain score	83%
Reduced complications	67%
Reduced ITU admissions	46%
Reduced readmissions	42%

Enhanced Recovery Partnership NHS

Analgesia strategies

- Most units have multiple strategies
- Epidurals - 73% units
- PVC - 93% units
- Intra-thecal - 10% units
- IV morphine - 90% units
- Of 28 units using PVCs, 16 (57%) put into >50% patients

Enhanced Recovery Partnership NHS

Post operative analgesia

- 83% units have a standardised pain control guideline
- 63% guidelines are thoracic surgery specific
- Containing:
  - Regular laxatives in 75% units
  - Regular NSAIDs in 26% units

Enhanced Recovery Partnership NHS

Post operative physiotherapy

- 79% units have standardised post operative physiotherapy
- This is in 69% of cases thoracic surgery specific
- Day 1: Patients are
  - Sat out in a chair: 97% units
  - Mobilised: 86% units

Enhanced Recovery Partnership NHS

Post discharge follow up

- 97% units give patients thoracic surgery specific advice before discharge
- This is predominantly:
  - Written 75% units
  - Verbal 89% units
- Additionally 26% units telephone within one week of discharge
- Two units make home visits

Enhanced Recovery Partnership NHS

Post discharge follow up

- Contact benefits:
  - Reduce anxiety 95%
  - Reduce readmission 81%
  - Increase patient satisfaction 91%
- Comments:

"Helps address problems with pain control"
"Most patients contacted by lung CNS - we only contact the 'fallen few'"
"Useful point of contact for any on-going issues"
"Allows OPA to be brought forward if necessary"
"No evidence of any benefit"

APPENDIX 2- ENHANCED RECOVERY IN THORACIC SURGERY: BIRMINGHAM HEARTLANDS HOSPITAL MANUAL

APPENDIX 3: ELECTRONIC PRECRIPTION FOR THORACIC SURGICAL PATIENTS: 6 NEW BUNDLES [TO REPLACE EXISTING 2 BUNDLES]

Drug group	Thoracic bundle (epidural)	Thoracic bundle (PVC)	Thoracic bundle (Intra-thecal)	Thoracic bundle (IV morphine infusion)	Thoracic bundle (PCA)	Thoracic bundle (PVC + IV morphine infusion)
Analgesics	Epidural	PVC + PCA	Intra-thecal inj + PCA	IV morphine infusion	IV morphine (PCA)	PVC + IV morphine infusion
		IV morphine in recovery	IV morphine in recovery	IV morphine in recovery	IV morphine in recovery	IV morphine in recovery
	Paracetamol 1g QDS REG PO/IV	Paracetamol 1g QDS REG PO/IV	Paracetamol 1g QDS REG PO/IV	Paracetamol 1g QDS REG PO/IV	Paracetamol 1g QDS REG PO/IV	Paracetamol 1g QDS REG PO/IV
Anti-emetics	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV	Cyclizine 50mg TDS PRN PO/IM/IV
	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV	Ondansetron 4mg QDS PRN PO/IV
Laxatives	Docusate Sodium 100mg TDS REG PO	Docusate Sodium 100mg TDS REG PO	Docusate Sodium 100mg TDS REG PO	Docusate Sodium 100mg TDS REG PO	Docusate Sodium 100mg TDS REG PO	Docusate Sodium 100mg TDS REG PO
	Senna 15mg Nocte REG PO	Senna 15mg Nocte REG PO	Senna 15mg Nocte REG PO	Senna 15mg Nocte REG PO	Senna 15mg Nocte REG PO	Senna 15mg Nocte REG PO
	Macrogol 1 sachet TDS PRN PO	Macrogol 1 sachet TDS PRN PO	Macrogol 1 sachet TDS PRN PO	Macrogol 1 sachet TDS PRN PO	Macrogol 1 sachet TDS PRN PO	Macrogol 1 sachet TDS PRN PO

VTE prophylaxis	TEDS 1 pair	TEDS 1 pair	TEDS 1 pair	TEDS 1 pair	TEDS 1 pair	TEDS 1 pair
Nebulisers	0.9% Salbutamol 2.5mg QDS REG NEB	0.9% Salbutamol 2.5mg QDS REG NEB	0.9% Salbutamol 2.5mg QDS REG NEB	0.9% Salbutamol 2.5mg QDS REG NEB	0.9% Salbutamol 2.5mg QDS REG NEB	0.9% Salbutamol 2.5mg QDS REG NEB
	0.9% Saline 5ml 2h REG NEB	0.9% Saline 5ml 2h REG NEB	0.9% Saline 5ml 2h REG NEB	0.9% Saline 5ml 2h REG NEB	0.9% Saline 5ml 2h REG NEB	0.9% Saline 5ml 2h REG NEB
Respiratory depression	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)	Humidified oxygen (Aim sats 96%, unless known CO_2 retainer aim 88-92%)
	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)	Naloxone 400 micrograms PRN (If resp rate < 8 breaths / min)

PCA- patient controlled analgesia

PVC- paravertebral catheter

APPENDIX 4- MY LUNG SURGERY HANDBOOK

APPENDIX 5: LITERATURE SEARCH STRATEGIES FOR CHEST DRAIN MANAGEMENT AND CARBOHYDRATE LOADING

Chest drain management

Search History

1. MEDLINE; exp CHEST TUBES/; 1910 results.
3. MEDLINE; (fast AND track AND surgery).ti,ab; 702 results.
4. MEDLINE; exp THORACOSTOMY/ OR exp THORACIC SURGERY/; 10991 results.
5. MEDLINE; exp DRAINAGE/is, mt, ut [is=Instrumentation, mt=Methods, ut=Utilization]; 15434 results.
6. MEDLINE; ("chest drain*" OR "digital drains").ti,ab; 1112 results.
7. MEDLINE; 1 OR 5 OR 6; 17583 results.
8. MEDLINE; "enhanced recovery".ti,ab; 846 results.
9. MEDLINE; 4 OR 8; 11837 results.
10. MEDLINE; 7 AND 9; 503 results.
11. MEDLINE; 10 [Limit to: English Language and Humans and Publication Year 2000-Current and (Clinical Queries Reviews best balance of sensitivity and specificity or Therapy best balance of sensitivity and specificity)]; 56 results.
12. EMBASE; exp THORAX DRAINAGE/; 5593 results.
13. EMBASE; ("chest drain*" OR "digital drains").ti,ab; 1432 results.
14. EMBASE; 12 OR 13; 6297 results.
15. EMBASE; (fast AND track AND surgery OR enhanced AND recovery).ti,ab; 14623 results.
16. EMBASE; exp *THORAX SURGERY/; 195328 results.
17. EMBASE; 15 OR 16; 209660 results.
18. EMBASE; 14 AND 17; 1882 results.
19. EMBASE; 18 [Limit to: Human and English Language and (Clinical Queries Reviews best balance of sensitivity and specificity or Therapy best balance of sensitivity and specificity) and Publication Year 2000-Current]; 235 results.
20. MEDLINE,EMBASE; Duplicate filtered: [10 [Limit to: English Language and Humans and Publication Year 2000-Current and (Clinical Queries Reviews best balance of sensitivity and specificity or Therapy best balance of sensitivity and specificity)]], [18 [Limit to: Human and English Language and (Clinical Queries Reviews best balance of sensitivity and specificity or Therapy best balance of sensitivity and specificity) and Publication Year 2000-Current]]; 291 results.

Carbohydrate loading

Search History

1. MEDLINE; exp *SURGICAL PROCEDURES, OPERATIVE/; 1339179 results.
2. MEDLINE; exp PREOPERATIVE CARE/; 55982 results.
3. MEDLINE; exp ENERGY DRINKS/; 57 results.
4. MEDLINE; "carbohydrate drinks".ti,ab; 31 results.
5. MEDLINE; (carbohydrate AND drink* OR carbohydrate AND supplements OR loading AND carbohydrate AND drinks).ti,ab; 40 results.
6. MEDLINE; exp *DIETARY CARBOHYDRATES/ad OR exp *BEVERAGES/ [ad=Administration & Dosage]; 60022 results.
7. MEDLINE; exp DIETARY SUPPLEMENTS/; 34191 results.
8. MEDLINE; 3 OR 4 OR 5 OR 6 OR 7; 93000 results.
9. MEDLINE; exp LENGTH OF STAY/; 52842 results.
10. MEDLINE; exp COSTS AND COST ANALYSIS/; 169652 results.
11. MEDLINE; exp QUALITY OF LIFE/; 104415 results.
12. MEDLINE; exp PATIENT SATISFACTION/; 55239 results.
13. MEDLINE; 9 OR 10 OR 11 OR 12; 357542 results.
14. MEDLINE; 1 AND 2 AND 8 AND 13; 13 results.
15. MEDLINE; (preoperative OR pre AND operative).ti,ab; 38413 results.
16. MEDLINE; 2 OR 15; 89880 results.
17. MEDLINE; 1 AND 8 AND 13 AND 16; 16 results.
18. EMBASE; exp SURGICAL PATIENT/; 18584 results.
19. EMBASE; exp SURGICAL TECHNIQUE/; 926606 results.
20. EMBASE; 18 OR 19; 938752 results.
21. EMBASE; exp BEVERAGE/ OR exp DIET SUPPLEMENTATION/; 174260 results.
22. EMBASE; (carbohydrate AND drink* OR carbohydrate AND supplements OR loading AND carbohydrate AND drinks).ti,ab; 47 results.
23. EMBASE; exp CARBOHYDRATE DIET/; 13676 results.
24. EMBASE; 21 OR 22 OR 23; 186822 results.
25. EMBASE; exp PREOPERATIVE CARE/ OR exp PREOPERATIVE PERIOD/; 179168 results.
26. EMBASE; (preoperative OR pre AND operative).ti,ab; 52283 results.
27. EMBASE; 25 OR 26; 217240 results.
28. EMBASE; exp LENGTH OF STAY/; 67841 results.
29. EMBASE; exp COST/ OR exp COST BENEFIT ANALYSIS/ OR exp COST EFFECTIVENESS ANALYSIS/; 328754 results.
30. EMBASE; exp QUALITY OF LIFE/; 219299 results.
31. EMBASE; exp PATIENT SATISFACTION/; 75868 results.
32. EMBASE; 28 OR 29 OR 30 OR 31; 638117 results.
33. EMBASE; 20 AND 24 AND 27 AND 32; 26 results.
34. MEDLINE,EMBASE; Duplicate filtered: [1 AND 8 AND 13 AND 16], [20 AND 24 AND 27 AND 32]; 42 results.

APPENDIX 6: GAP ANALYSES

Abbreviations

ERAS- enhanced recovery after surgery

CTS- cardiothoracic surgery

OPC- outpatient clinic

DOSA- day of surgery admission

POAC- pre-operative assessment clinic

VATS- video assisted thorascopic surgery

ECHO- echocardiography

PFT- pulmonary function test

UHSM- university hospital of south manchester

R+D- research and development

CQUIN- commissioning of quality innovation payment framework

TAH- total abdominal hysterectomy

LOS- length of stay

UGI- upper gastrointestinal surgery

EVAR- endovascular aortic aneurysm repair

AAA- abdominal aortic aneurysm

CONTENTS

1. The Enhanced Recovery Pathway – Gap Analysis Thoracic Surgery (BIRMINGHAM)

Elements	Current practice status	Notes / actions	Responsibility
Getting the patient in best possible condition			
Primary Care Input			
Optimising Haemoglobin levels	No		
Managing pre-existing co morbidities e.g. Diabetes/Hypertension	No		
Pre-operative			
Health and Risk Assessment	POAC		
Good Quality Patient Information	POAC- quantity (too much) and quality (too detailed)		
Informed decision making	Discussion in OPC		
Managing patient's expectations of what will happen to them	???		
Optimised health/medical condition	???		
Therapy Advice	???		
Carbohydrate loaded drinks (high energy drinks)	No		
Maximising patients hydration	? Patient information may lead to excess dehydration		
Discharge Planning – expected date of discharge (EDD)	? Given		
Admission			
Admit on day of surgery	Yes		
Optimise fluid hydration	Unclear- ?dehydrated prior to surgery. No pre-op drinks or hydration		
Avoid routine use of sedative pre-medication	Yes		
Carbohydrate loaded drinks (high energy drinks)	No		

Additional Actions

The patient has the best possible management during surgery

Intra-operative			
Minimally invasive surgery if possible	Yes		
Individualised goal-directed fluid therapy	No		
Avoid crystalloid overload	Yes		
Epidural management	Yes		
Use of regional/spinal and local anaesthetic with sedation	Increasing use of PVC+PCA		
Hypothermia prevention	Yes		

Additional Actions

The patient experiences the best post-operative rehabilitation

Post Operative			
No routine use of wound drains	Yes		
Chest drain management	Protocol- but ?compliance		
Active planned mobilisation within 24 hours	Yes		
Early oral hydration	Yes		
Early oral nutrition	Yes		
IV therapy stopped early	Yes, but Recovery ask for IVI		
Catheters removed early	Yes		
Regular oral analgesia e.g. paracetamol and NSAIDS	Yes, but ?protocol compliance		
Avoidance of systemic opiate-based analgesia where possible	Variety in analgesic techniques: Morphine infusion, PVC+PCA		
Follow-up			
Discharge on planned day or when criteria met	?Yes		
Therapy support (Physio, Dietician)	Yes		
24 hour telephone follow-up call if appropriate	No		

2. ERAS Unit visit- Manchester (University Hospital of South Manchester)

Event: Pulmonary rehabilitation for lung cancer patients

Mr B Naidu and Mr R Wotton invited speakers

Date: 11th October 2012

Nurse-led CTS clinic for cardiothoracic patients:

Discussion with Kath Hewitt (Nurse lead CTS)

Staff: 2 Thoracic nurses, 3 cardiac nurses, 1 health care assistant

2 permanent rooms in OPC

5 days/week (Monday-Friday): 8am – 5pm

Combined clinic- both cardiac and thoracic patients seen

Access:

- Patient can phone direct
- Ward referral
- GP referral
- From OPC

Two major functions:

1. Pre-operative assessment
2. Outpatient review and management.

   E.g.

   - ICDs, inc Pleurex (for thoracic/respiratory/oncology patients)
   - Flutter bags (clamp after 3 weeks)
   - Wound review
   - VAC therapy
   - Histology results
   - GP advice

Day of surgery admission (DOSA)

Not routine, admitted night before surgery

Clerked in POAC

Drug chart written on arrival or admission

Barriers to DOSA:

- Anaesthetists- prefer to see patient night before surgery
- Ward nurses- some opposition ?reason

A few patients go to admission lounge on day of surgery

Pre-operative assessment clinic (POAC)

Pre-admission controlled by CTS clinic

UHSM has central POAC, but Thoracic surgery has control over own patient pool

Plan:

- Take POAC to local referring hospitals (Issues ?rooms/space,time,local expertise)

Pre-operative investigations:

- X-match for VATS lobes/sleeve/pneumos/chest walls/decorts/pectus/thymus

Anaesthetic input:

- Available via email/telephone
- Few cancellations on day of surgery
  - Occasionally need ECHO/PFTs

ERAS at UHSM

Discussion with Wendy Winn (ER lead nurse, UHSM)

Background

- Colorectal nurse seconded to ERAS for 6months initially (Funded by cancer network to kick start ERAS)
- Now permanent position (Funded by R+D/Service transformation- pay salary)

ERAS implementation

Started with colorectal 18 months ago

- Ward driven

Nursing staff confident to make decisions

ER lead post established

- Remit:
  - Independent of ward staff
  - Review practice and challenge decisions
- Working group per speciality
  - Monthly meetings (Directorate manager, Lead consultant, Service facilitator, Ward manager, PT, OT (orthopaedics), Nurse specialist, POAC manager, Matron)

POAC was colorectal on ward but now incorporated into central UHSM POAC

CQUINS

7 ER CQUINS established:

- For cancer patients in Colorectal, Gynaecology oncology (TAH), Urology (Cystectomy)

- Communication of decision of plan to GP within 10 days
- Communication of information to patient of decision within 10 days
- See specialist nurse for review prior to admission
- DOSA + SAS from 1/10/12
- On ERAS pathway
- On ERAS pathway on discharge summary
- Contact with nurse specialist nurse post-surgery within 10 days

Planned roll-out

- Urology
    - Two consultants: changed practice, technique to reduce surgical time. Subsequent LOS reduction (23 to 17 days)
    - Cystectomy 2012- achieved
    - Prostatectomy/nephrectomy Oct 2012

- Vascular
    - EVAR/AAA ?date

- UGI
    - New consultant (trained in Guildford- expert minimally invasive group)
    - Other 2 consultants keen to implement ERAS. Many principles adopted already.

- Thoracic surgery
    - Drive to implement
    - Nil in place currently.

- But, Thoracic POAC independent and can thus more easily facilitate DOSA more easily
- Meeting today to kick start ERAS

The Enhanced Recovery Pathway – Gap Analysis Thoracic Surgery (MANCHESTER 19/9/12)

Elements	Current practice status	Notes / actions	Responsibility
Getting the patient in best possible condition			
Primary Care Input			
Optimising Haemoglobin levels	No		
Managing pre-existing co morbidities e.g. Diabetes/Hypertension	No		
Pre-operative			
Health and Risk Assessment	Verbal by LCNS e.g. surgery info/VTE		
Good Quality Patient Information	Verbal by LCNS e.g. surgery info/VTE		
Informed decision making	Verbal discussion LCNS/OPC		
Managing patient's expectations of what will happen to them	Verbal discussion LCNS/OPC		
Optimised health/medical condition	Too late		
Therapy Advice			
Carbohydrate loaded drinks (high energy drinks)	No- no access		
Maximising patients hydration	No		
Discharge Planning – expected date of discharge (EDD)	Yes		
Admission			
Admit on day of surgery	No- night before		
Optimise fluid hydration	None		
Avoid routine use of sedative pre-medication	Yes		
Carbohydrate loaded drinks (high energy drinks)	No		

Additional Actions

Clinic and POAC separate

Thoracic NS led clinic

- **Open door/drop-in service, mon-fri 9-5**
- **Incorporates POAC/drain clinic/pleurex**
- **Some paperwork inc EDD, contact numbers, post op info**
- **No patient diary**

The patient has the best possible management during surgery

Intra-operative			
Minimally invasive surgery if possible	Started		
Individualised goal-directed fluid therapy	No- some trustwide use in other specialities		
Avoid crystalloid overload	???		
Epidural management	Yes- use of epid/PVC/regional blocks		
Use of regional/spinal and local anaesthetic with sedation	Yes		
Hypothermia prevention	Yes		

Additional Actions

All patients go to CTCCU (CTS ITU/HDU)

- **Includes cardiac/ECMO/transplants for min.24hrs**
- **If full leads to cancelled lists**

The patient experiences the best post-operative rehabilitation

Post Operative			
No routine use of wound drains	Yes		
Chest drain management	100% rocket drains, usually only one		
Active planned mobilisation within 24 hours	Planned, but patients in CTCCU so may not be mobilised		
Early oral hydration	Yes		
Early oral nutrition	Yes		
IV therapy stopped early	Yes		
Catheters removed early	Yes. Unusual to have catheter even with epidural		
Regular oral analgesia e.g. paracetamol and NSAIDS	'Hit & miss'. No protocol.		
Avoidance of systemic opiate-based analgesia where possible	Yes		
Follow-up			
Discharge on planned day or when criteria met	?		
Therapy support (Physio, Dietician)	?		
24 hour telephone follow-up call if appropriate	Have access. Phones 7-21 days post surgery		

3. The Enhanced Recovery Pathway – Gap Analysis Thoracic Surgery (BRISTOL)

Elements	Current practice status	Notes / actions	Responsibility
Getting the patient in best possible condition			
Primary Care Input			
Optimising Haemoglobin levels	POAC identifies problems		
Managing pre-existing co morbidities e.g. Diabetes/Hypertension	POAC identifies problems		
Pre-operative			
Health and Risk Assessment	OPC+POAC same day POAC has on hand anaesthetic consultants to review pts		
Good Quality Patient Information	Patient diary EDD given		
Informed decision making	Consent form (unsigned) given to patient to take home and read. Brings on DOSA		
Managing patient's expectations of what will happen to them	See above		
Optimised health/medical condition	POAC		
Therapy Advice			
Carbohydrate loaded drinks (high energy drinks)	Yes. 2/7 pre surgery High CHO on day of surgery 7/7 post surgery		
Maximising patients hydration	Can drink water until 2hrs prior to surgery		
Discharge Planning – expected date of discharge (EDD)	Given to patient in OPC		
Admission			
Admit on day of surgery	Yes. Routine		
Optimise fluid hydration	Water until 2hrs prior to surgery		
Avoid routine use of sedative pre-medication	Yes		
Carbohydrate loaded drinks (high energy drinks)	Yes		

Additional Actions

The patient has the best possible management during surgery

Intra-operative			
Minimally invasive surgery if possible	Yes. ¾ surgeons do VATS (53% lobes done by VATS, June 2012)		
Individualised goal-directed fluid therapy	No		
Avoid crystalloid overload	Yes		
Epidural management	Reducing number. PVC the norm.		
Use of regional/spinal and local anaesthetic with sedation	PVC the norm		
Hypothermia prevention	Yes		

Additional Actions

The patient experiences the best post-operative rehabilitation

Post Operative			
No routine use of wound drains	Yes		
Chest drain management	One ICD as standard		
Active planned mobilisation within 24 hours	Yes		
Early oral hydration	Yes		
Early oral nutrition	Yes		
IV therapy stopped early	None prescribed		
Catheters removed early	Yes		
Regular oral analgesia e.g. paracetamol and NSAIDS	Yes, structured analgesic ladder		
Avoidance of systemic opiate-based analgesia where possible	Yes. PCA used with PVC. Taken down as early as possible		
Follow-up			
Discharge on planned day or when criteria met	Yes. Consultant led WR everyday		
Therapy support (Physio, Dietician)	Yes		
24 hour telephone follow-up call if appropriate	Yes. Called in first week post surgery		